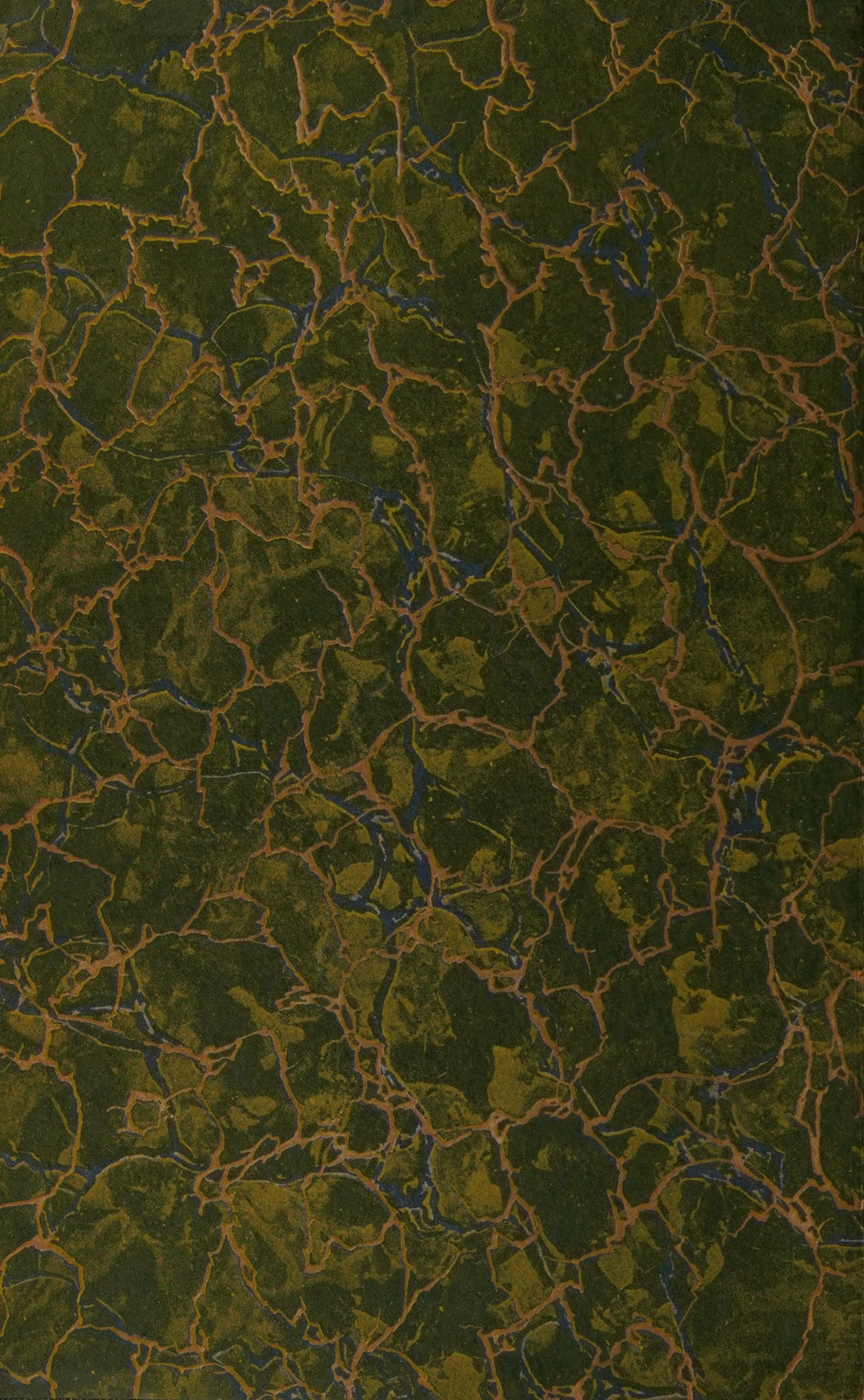

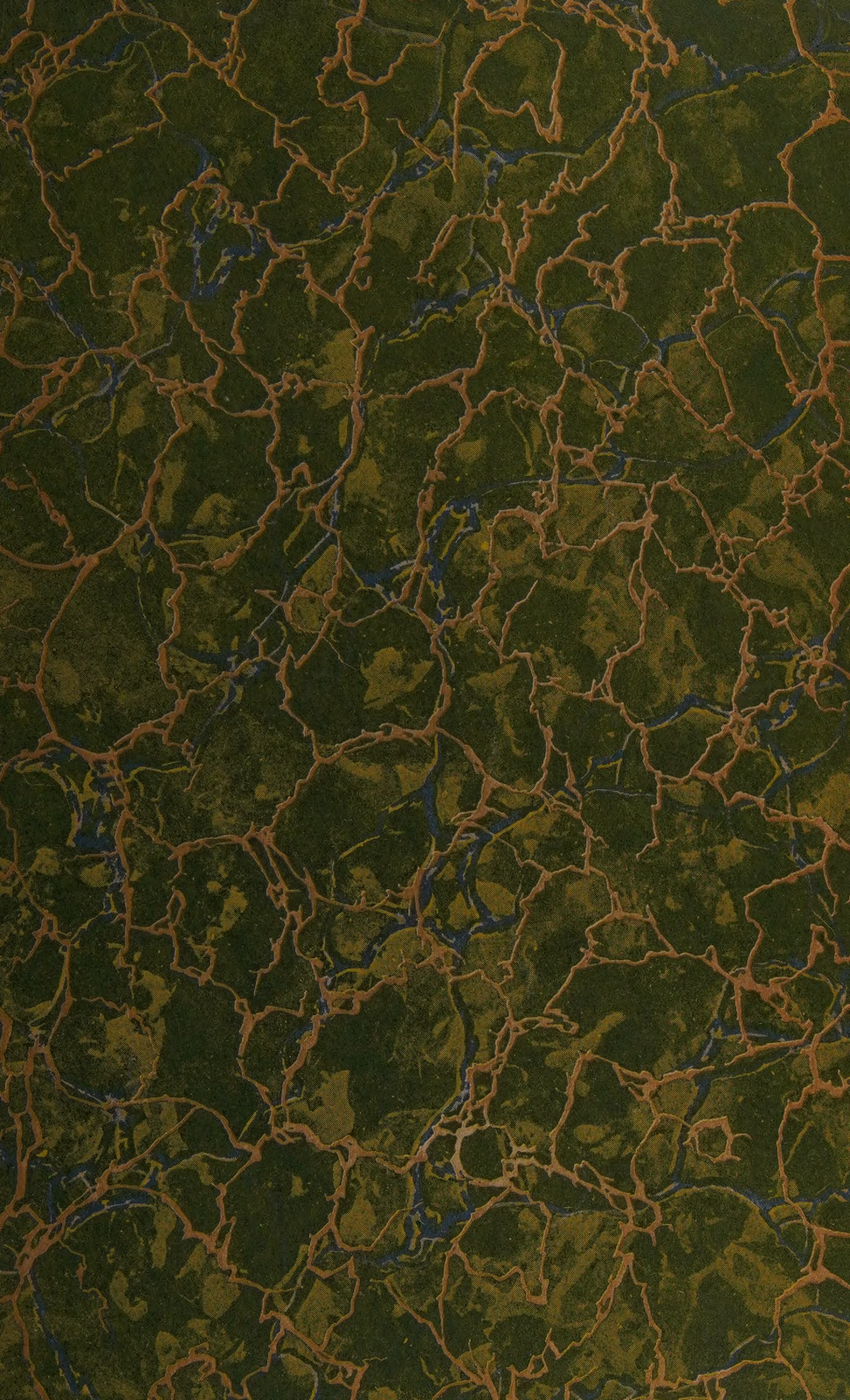

Sam L. Sterrett

# International Library of Technology

346

A SERIES OF TEXTBOOKS FOR PERSONS ENGAGED IN ENGINEERING PROFESSIONS, TRADES, AND VOCATIONAL OCCUPATIONS OR FOR THOSE WHO DESIRE INFORMATION CONCERNING THEM. FULLY ILLUSTRATED

# SPECIFICATION WRITING
# SPECIFICATION-WRITING MEMORANDA
# ESTIMATING AND CALCULATING QUANTITIES
# CONTRACTS

SCRANTON
INTERNATIONAL TEXTBOOK COMPANY
1924

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# PREFACE

The volumes of the International Library of Technology are made up of Instruction Papers, or Sections, comprising the various courses of instruction for students of the International Correspondence Schools. The original manuscripts are prepared by persons thoroughly qualified both technically and by experience to write with authority, and in many cases they are regularly employed elsewhere in practical work as experts. The manuscripts are then carefully edited to make them suitable for correspondence instruction. The Instruction Papers are written clearly and in the simplest language possible, so as to make them readily understood by all students. Necessary technical expressions are clearly explained when introduced.

The great majority of our students wish to prepare themselves for advancement in their vocations or to qualify for more congenial occupations. Usually they are employed and able to devote only a few hours a day to study. Therefore every effort must be made to give them practical and accurate information in clear and concise form and to make this information include all of the essentials but none of the non-essentials. To make the text clear, illustrations are used freely. These illustrations are especially made by our own Illustrating Department in order to adapt them fully to the requirements of the text.

In the table of contents that immediately follows are given the titles of the Sections included in this volume, and under each title are listed the main topics discussed.

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# SPECIFICATION WRITING

## PRINCIPLES OF SPECIFICATION WRITING

**1. Definition of a Specification.**—The general meaning of the word *specification* is specific description, that is, a detailed and definite statement with regard to any particular subject.

A specification with regard to a particular set of drawings, therefore, is a definite and formal mention of particulars explanatory (supplementary to the drawings and details) of the method of carrying out the drawings, both as to labor and as to materials, that enter into the construction of a building.

**2. General Relations.**—Besides the formal and definite statement of the material and labor required to carry out the drawings, the specifications should also take up the relations between the various parties, and instruments necessary to the carrying out of the contract. These parties and instruments include the architect, owner, contractor, contract, specifications, and drawings. The various relations between these parties and instruments may be grouped under five heads as given below:

1. The relation between the architect and the contractor.
2. The relation between the contractor and the law.
3. The relation between the contractor and the owner.
4. The relation between the contract, drawings, and specifications, and the contractor and the architect.
5. The relation between the architect and the owner.

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## DIVISIONS OF SPECIFICATION

**3. First Division.**—These five relations are taken up and stated clearly under the first great division of the specification, which is headed General Conditions. The usual specification, therefore, may be said to be composed of two great divisions—the general conditions and the balance of the document.

Under the first relation would come statements with regard to the reporting by the contractor to the architect of errors that the contractor may discover in either the drawings or the specifications, the approval of subcontractors by the architect, and all similar matters necessary to be explained in this connection.

Under the second relation would come the statements outlining the duties of the contractor as to liability for loss of life, the obtaining of permits, and other matters of a similar nature.

Under the third relation would come the explanations of what materials, if any, the owner is to furnish, and the owner's approval of extra work, payments, etc.

Under the fourth relation should be any matter referring to the interpretation of the drawings and specifications, the return of the same to the architect on the completion of the building, and any reference to the contract that may be considered necessary.

Under the fifth relation, the exact position of the architect with reference to the owner should be made clear. This is a matter much misunderstood and is worthy of careful attention.

**4. Second Division.**—Following these general conditions comes the second great division, which specifies the labor and material necessary for the erection of the building, and is usually distributed under the following headings, or similar ones:

(1) Excavation and mason work (includes plastering); (2) carpenter work; (3) painting and glazing; (4) hardware;

(5) plumbing and sheet-metal work; (6) heating; (7) electrical work.

**5.** The foregoing titles are only intended to give an idea of what the usual list will be. For a large building, there would be other headings, such as structural steel and ironwork, art glass, etc. Under each of these headings come the subheadings, which comprise the various matter included under that particular heading.

---

## HOW TO WRITE SPECIFICATIONS

**6.** Having discussed the meaning of specifications, the proper method of writing such documents will now be considered. In the first place, the person who is to write the specification should have a knowledge of the drawings, which should be in pencil in a completed state. (The drawings are in pencil at this stage in order that small changes that suggest themselves may be made while writing the specifications.) The desires of the owner and the conditions of the site should also be known, and the writer should be thoroughly versed in building construction. Constant vigilance should be exercised in order that the latest improvements of science and art may be specified; and if it is desired to give the owner the advantages of all the improvements that are constantly being made, the merits of the various articles that the trade brings to notice should be investigated and decided on. The writer should therefore be particular to keep in touch with the arts and crafts through the various publications and catalogs of the manufacturers, and should have as complete a file of these publications as possible.

A general outline consisting of the headings and their subheadings, as already mentioned, should be arranged and made as nearly perfect as possible. After this, the writer should proceed to specify, under the subheadings, the labor and material that is desired in each case. The drawings and other data for the work should constantly be kept in plain view, and the writer should strive at all times for a mind

picture of the entire building and the particular work that is being written up, in order that details may be clearly expressed and the liability to omit anything may be reduced to a minimum.

**7.** The writer should strive for several characteristics in the specifications. First of all, *brevity*. As few words as possible should be used in expressing what is desired, and repetition should be carefully avoided. Second, *clearness*—simple words instead of unusual words should be employed. The technical terms in common use among tradesmen should be known and used in preference to non-technical words, where there is danger of ambiguity. General terms should be avoided whenever possible. Third, *order*—the headings should be arranged in approximately the same order in which the work referred to by them would be executed. The entire specification should be headed with an index of subtitles, which are numbered consecutively in the left-hand margin or at the beginning of paragraphs.

**8.** As an aid to the contractor in figuring, and to the superintendent, lists of all items of carpenter work, mason work, ironwork, etc. are often inserted at the beginning or at the end of these divisions. For example, under carpenter work, something like this might be stated:

The carpenter work includes the following, which is not necessarily an entire list of this work but is merely given as an aid to the contractor.

All framing timber, hemlock
Sheathing, roof and sides
Yellow-pine flooring, first floor
Yellow-pine flooring, second floor
Yellow-pine flooring, third floor
Sheathing paper
Shingles
35 doors, single
8 doors, double
57 windows, double-hung
12 casements
Trim for doors and windows
1″ × 10″ molded base, first and second floors
1″ × 8″ molded base, third floor
Main stairway, yellow pine
Wainscot in kitchen
Wainscot in bathroom
Cupboards in kitchen
Cupboards in cellar
Cupboards in laundry

**9.** As a further aid to the contractor, and to avoid misunderstanding, it is often customary to place preceding the

general conditions, instructions to the various contractors as to what their bids are to include. Very often, the entire work is placed in the hands of one contractor, but the owner will save the percentage usually added by the general contractor to subcontracts by dividing and making separate contracts for such work as plumbing, electric wiring, heating, etc. Such a division of contracts, however, is very likely to cause a certain amount of friction between the different contractors, which might be avoided by having the contracts under one head.

**10.** A copy of the specifications is made for each set of drawings that is employed, and usually the general contractor, the principal subcontractors, and the owner are supplied with copies.

A list of the drawings, by sheet number, with the contents of each sheet stated, is usually placed following the general conditions.

**11.** In case the entire work is not under one contract, it is well to state at the beginning of each trade division, as for example, carpenter work, mason work, etc., that "the general conditions at the beginning of the specifications are hereby made a part of the contract for this division of the work except where they obviously do not apply"; or, it may be stated that certain articles of the general conditions designated by number are to be considered as part of the specification.

**12.** In describing a subject that entails a reference to an item in another trade, it will be a great convenience to the contractor, superintendent, and all who refer to the specification to find a parenthetical reference locating the item by paragraph number.

## SUBJECT MATTER OF SPECIFICATIONS

**13.** In order that the purpose and scope of each part of the specification may be clearly understood, the various divisions will be taken up separately, with explanations of the purpose and meaning of each.

**14. Title.**—The title of the specification, which states the nature and the location of the building and for whom the building is to be erected, should appear on the cover or first sheet. If there is to be more than one specification (for example, if the plumbing, electric wiring, and heating specifications are to be under separate covers), it will be well to number them, and if the work has a particular number, it should appear here. The architect's name and office address should also be on this sheet.

**15. Headings and Subheadings.**—The general headings should be centered, and the subheadings should be placed on the left side of the sheet immediately over or alongside the paragraph to which they refer.

**16. Index.**—On the sheets following the title of the specifications should appear the index of headings and subheadings. Each item of the index should be numbered to correspond with its number at the beginning of each paragraph on the margin of the specification. Obviously, the making of the index should be left until after the specification is typewritten. While this style of index requires more time and labor than an index of pages only, it is very thorough, and will greatly assist the contractor, owner, or any one not familiar with the document in finding the specification of any particular item. As a further convenience it might be arranged alphabetically.

**17. Instructions to Bidders.**—Under the heading Instructions to Bidders, on the sheet following the index, should appear instructions governing the bids, which should state whether the entire work is to be covered by one bid or whether it is to be divided, as stated in Art. **52.**

**18. General Conditions.**—The general conditions of the specification follow the instructions to bidders. These conditions should be subdivided under the five relations stated in Art. **2**, after which should come the body of the document, which usually begins with excavation and mason work.

The quoted matter given under the heading General Conditions is that in general use by the best architects. Special conditions, however, might demand additions or omissions to or from this.

## GENERAL CONDITIONS

### THE ARCHITECT AND THE CONTRACTOR

**19.** "The contractor shall furnish suitable and safe means of access for the superintendent or architect to all parts of the work."

This provision is to enable the architect or his superintendent to examine the work at all points necessary and to inspect material wherever stored.

**20.** "The position of the hoisting apparatus, boiler, etc. shall be approved by the architect."

It is important that the hoisting engines or other engines used in a building shall be so placed that they will not transmit excessive vibration to the building, and that the smoke pipe from the boiler should be so situated that the smoke will not damage finished work or be a nuisance to neighboring property owners.

**21.** "Any work or material not in conformity with the drawings and the specifications must be removed at the expense of the contractor upon a written order from the architect or his superintendent, and made to conform with the drawings and specifications."

The removal of defective material from the work as soon as possible after discovery is important, as some of it may otherwise get into the building in spite of the superintendent's vigilance.

**22.** "In any dispute between contractors, or between contractors and owners, the architect is to be the arbitrator, and his decision will be final in the matter."

As a rule, the architect always knows more about the subject matter of any dispute that may arise between the parties concerned than any outsider, generally gives a fair decision, and charges nothing for the service rendered. If the parties employ arbitration or submit their dispute to the courts, it entails considerable expense and is less liable to end in justice being done.

**23.** "The architect shall have the power to order the removal of rubbish that may accumulate, from time to time, if he considers its removal necessary."

Contractors very often neglect to keep the premises well cleared of rubbish; frequently, this is detrimental and sometimes delays the work.

**24.** "Samples of all materials and specimens of finish proposed to be used in the work must be submitted to the architect and his approval of the same obtained in writing. Only materials equal to such approved samples shall be used in the building."

The purpose of this clause is to give the architect a definite standard to follow, and is applicable to tiling, brickwork, slate, stains for woodwork, etc.

**25.** "Any test of cement, stone, steel, or other material desired by the architect must be made under his direction, at the contractor's expense."

This clause refers to tests to ascertain tensile, compressive, or other values for cement, steel, etc.

**26.** "No certificates for payments for extra work shall be issued except on the production of a written order from the owner, authorizing the same. The owner will not be liable for any extra work not ordered in this way."

There should be no trouble in regard to the cost of extra work if this clause is carried out, and it should be fully explained to the client. During the progress of erection, it

is a common occurrence for an owner to visit the building and, without consulting the architect or going through the procedure stated in the clause, direct the contractor to make changes. If the contractor carries out the verbal orders, the probabilities are that the owner, at the final settlement, will be much astonished to learn that the bill of extras is very large, and is sometimes unreasonable enough to blame the architect for the same. The order is usually made by the architect (after explaining it to the owner) and indorsed in writing by the owner.

**27.** "The general contractor and other contractors must submit to the architect a list of their subbidders, and only such subbids as are approved in writing by the architect shall be used. The general contractor will be held responsible for all the work of the subcontractors under him."

The purpose of this clause is to avoid irresponsible subcontractors. If such contractors once get on the works, it is very difficult, if not impossible, to obtain good results from them. If the architect is well informed in regard to the various contractors, there should be no trouble in arranging a list of several reliable men from which the general contractor may choose. The responsibility of the general contractor for the work of the subcontractors should be strictly insisted on and clearly stated in the specifications, otherwise the work of the superintendent is likely to be greatly hampered. See Arts. **44** and **48**.

**28.** "A schedule of the quantities and prices on which the contract is based shall be furnished by the contractor for the use of the architect in making out certificates, etc."

This refers to the price of hemlock per thousand, excavation per cubic yard, concrete per cubic yard, masonry per perch, etc. This clause would probably be unnecessary for small buildings, but would be of great assistance to the architect during the erection of large structures.

**29.** "Statements showing in detail the amount of work and material furnished by the contractor for the proper

*Number of Payment* _____

*Owner* _____

_____

_____

*Number of Certificate* _____

*Date* _____

*Building* _____

_____

*Certificate sent to* _____

_____

_____

*Contract for* _____

_____

_____

*Amount of Contract* $_____

*Previously Paid* $_____

*Balance* $_____

**(This Certificate is an expression of opinion and does not form a legal responsibility upon the part of the Architect.)**

*Certificate No.* _____ $_____

_____ *19*____

_____

*Contractor for* _____

_____ *entitled to the* _____ *payment*

*amounting to* _____ *Dollars*

*according to Contract Dated* _____ *19*____

*Amount of Contract* $_____

*Previously Paid* $_____

*Balance* $_____

_____
*Architect*

_____

*Received the above Amount* _____

_____ *19*____

FIG. 1

period must be submitted when applications for certificates are made. The architect will issue certificates for all payments on the works, and no payment shall be made until certificate for same has been issued."

It is usual to either specify at this point what and when the payments are to be or to so state at the proper point in the contract. The common method is for the architect, at the first of each month, on the receipt of an estimate from the contractor, to issue a certificate stating that in his opinion the contractor is entitled to so much money (usually from 80 to 95 per cent. of the estimated value of the work done during the previous month). The certificate is given to the contractor, who presents it to the owner for payment. The owner retains the receipted certificate. Fig. 1 is a facsimile of such a certificate. It will be noted that it is merely an expression of opinion on the part of the architect. These certificates can be obtained in book form, from which they are torn when used. Stubs are left on which the date, the amount, and other information are recorded.

**30.** "The contractor, when the work is completed, shall notify the architect that he is ready for a settlement so that the architect, owner, or others interested may make any statements they wish or submit any bills before the architect issues his final certificate."

The statements, bills, etc. referred to are rebates on allowed inferior work, damages, or other claims for deductions on contract price, extras, and other things of a similar nature.

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### THE CONTRACTOR AND THE LAW

**31.** "All work on this building must be done in accordance with the building, sanitary, and other laws in force in the locality in which the building is to be erected, and such laws are hereby made a part of this specification, the same as if written in full herein."

The architect should be very careful to learn exactly what parts of the building and sanitary laws refer to the work in hand, in order to know just what is included by this clause.

**32.** "The contractor must give to the proper authorities all requisite notices relative to work in his charge, and he must obtain and pay for all permits, licenses, etc. that may be required by the law, gas and water, or lighting corporations."

This includes a permit, or official approval, of the drawings by the city building department; a plumbing permit, or approval of the drainage drawings by the city board of health or department having this particular work in charge; and permits for taps to gas, water, and electric-light mains.

**33.** "The general contractor shall maintain all necessary guards, railings, watchmen, lights, etc., and shall build temporary sidewalks, roofed passages, etc. that may be required to protect the public. Each contractor will be responsible for loss of life, damage to adjoining property or to the work of other contractors, caused by himself or his agents and will also be responsible for the loss of any tools or apparatus."

This protects the owner against suit by reason of injured workmen, damage to adjoining property, stolen tools, and the like, and insures the protection and convenience of the public in passing. The first part of the clause refers to a city building where a temporary sidewalk would span the vault under the sidewalk and be roofed over to protect pedestrians from falling materials.

---

### THE CONTRACTOR AND THE OWNER

**34.** "Proposals should be submitted on blank forms furnished by the architect, and the architect or owner reserves the right to reject any or all bids."

When representing the owner as here stated, the architect should be sure to have written authority from the owner to so act. The contractor frequently submits bids by letter instead of by blank form filled out. The bids should be addressed to either the architect or the owner, as the blank may call for or as the architect may direct.

**35.** "The contractor will be responsible for, and must make good at his own expense, any defects, settlements, damages, or injury to the work arising from improper work or material, which may appear within one year after the work is accepted."

This clause would cover such things as adulterated paint, poor mortar, or any work that at the time of acceptance appears perfect, but through some hidden defect develops imperfections later. When these imperfections are obviously caused by material, or workmanship not conforming with the specifications, this clause is intended to supply redress for the owner, but the chances are that it would be a difficult matter to enforce the same with some contractors, especially those who would knowingly allow the use of poor material.

**36.** "Any certificate issued, money paid, or occupancy of the building by the owner, will not imply the acceptance of work or materials not according to the drawings or specifications, and any such improper work must be replaced within the time of the guarantee mentioned."

The purpose of this clause is to make it impossible for the contractor to successfully contend that because the certificate was issued, defective work (afterwards discovered) done during the previous month has been accepted by the owner.

**37.** "The owner will insure all work paid for by him against damage caused by fire; but all work unpaid for, together with the contractor's tools, scaffolding, materials, etc., in the building, shall be entirely at the contractor's risk."

By this clause, the owner is relieved of liability for any damages caused by fire to any material belonging to the contractor or work unpaid for. In requiring the owner to insure the work as paid for, this clause makes it possible for him to continue the contract in case of a destructive fire, and thus protects the contractor from a possible termination of the work because of bankruptcy on the part of the owner.

THE CONTRACT, DRAWINGS, AND SPECIFICATIONS, AND THE CONTRACTOR AND ARCHITECT

38. "The general contractor shall verify all lines, levels, and dimensions shown on the survey or on the drawings, and will be held strictly responsible for the correctness of the setting out of the work. He will follow dimensions rather than the scale.

"The drawings and specifications are to be considered as cooperative, and any work shown on the drawings and not described in the specifications, or vice versa, or any work obviously necessary to complete the work within the limits of the drawings and specifications, is to be considered as part of the contract and is to be executed without extra charge in the same manner as the balance of the work. The figured dimensions shall always be taken in preference to the scale."

This places the responsibility for the setting out where it belongs, and requires the general contractor to include any small items that may have been overlooked by the architect, but which are obviously intended to be included. The architect should strive to make the drawings and specifications so complete, however, that this clause will not be necessary. This also requires that the contractor follow the figured dimensions rather than the scale, for it is practically impossible to always have scale dimensions correct, while the figured dimensions may be made absolutely so.

39. "The drawings and specifications are the property of the architect, and are to be returned to him on the completion of the building; but necessary copies may be obtained by the contractor at any time for legal or similar purposes in connection with this building."

The purpose of this clause is to protect the architect from the possible distribution of certain structural, artistic, or other ideas embodied in these drawings and specifications, which are possibly the results of many years' study and experience and in a measure constitute stock in trade. In case of any suit, however, between the contractor and the subcontractors or

the owner, involving work under the contract, copies of the drawings should be furnished to the contractor at cost in order that any necessary evidence may be obtained from them.

**40.** "Detail drawings will be furnished by the architect for all work for which such drawings may be necessary. The contractor must apply for such drawings at least 2 weeks before they will be needed. Any work that the contractor may do without these details will be at his risk, and if not according to the intention of the architect, must be removed.

"If any of the detail drawings show more expensive work than that indicated on the drawings on which the bids were made, or described in the specifications, the contractor must give the architect notice to correct them. If the contractor does not so notify the architect, he hereby agrees to carry out the work as detailed, without extra charge."

Detail drawings here referred to include all drawings not furnished at the time bids were placed by the contractors, and may be either full size or to scale. The architect should have ample notice of the contractor's desire for these drawings so as not to delay the work. The contractor should never be allowed to do work without these details; for if work is done in this manner, the spirit of the design will undoubtedly be destroyed, and if the contractor is not conscientious, inferior work may be substituted. On the other hand, if the architect in making the details is not careful to follow closely the small scale drawings from which the contractor has figured, the cost may be increased, in which case this clause provides a remedy for the contractor.

**41.** "The contractor must not change figures or otherwise alter the drawings, but must report all errors or discrepancies that he may discover to the architect for correction, before doing any work in which these errors are involved."

If an error should be found in the drawings, it is always well to have the architect make the correction. Sometimes

the contractor's foreman or other persons handling the drawings may discover what is thought to be an error, and should a change be made without consulting the architect much trouble may follow.

**42.** "The superintendent or the clerk of the works must keep a complete set of drawings in the office at the building, and any drawings removed for use on the work must be returned to the office at quitting time."

The drawings should always be left in the office of the superintendent or the clerk of the works, so that workmen, foreman, architect, and others may refer to them when necessary. A suitable table or shelf should also be provided on which they may be laid out.

**43.** "The general contractor must figure on doing everything necessary to carry out this contract in full, taking into consideration all the conditions of the site and abutting properties."

This provision insures the including of any necessary shoring of walls or abutting properties, the removal of any obstructions on the lot, and all such matters that may not be included in the specifications but are necessary in carrying out the work.

**44.** "Each contractor must do his best not to delay the other tradesmen, by doing his work promptly and at the proper time."

Often the plasterers are kept waiting because the lathers do not finish their work, or the lathers are kept back because the plumbers do not finish their work, and so on. This is another situation that illustrates the advisability of having all the work done under one contractor, who can in such cases be ordered to correct the matter.

**45.** "The general contractor must provide for an adequate supply of water for building purposes during the entire progress of the work.

"The general contractor will furnish the temporary heat required to dry out the plaster, etc."

Sometimes the owner furnishes both the water and the temporary heat. Often the heating apparatus is to be finished before the heat will be needed, and in this case the fuel might be furnished by the owner and a man to run the heater by the contractor, or, the fuel and man both might be furnished by the contractor, or vice versa. Whatever the arrangement may be, it should be plainly stated in the specifications so that there will be no misunderstanding.

**46.** "The general contractor shall maintain a telephone at the works for the use of the architect and his assistants."

This is a great convenience for the superintendent and the architect, and enables them to get into communication with the different contractors when necessary; the telephone may also be used for consultation with the office. On works of any magnitude, a telephone is almost indispensable.

**47.** "Contractor or contractors will give the work their personal supervision, both on the building and in the shop."

When a particular contractor of good reputation as a skilful mechanic is selected by the owner or the architect, they desire and depend on his skill and experience, hence the clause requiring his personal supervision.

**48.** "The general contractor shall employ a competent foreman to be on the work at all times. Any workmen who are incompetent must be removed at the request of the architect.

"The general contractor must protect both his own work and all the other work and material incorporated in or delivered to the building, and must pay for any damage to same due to negligence in this respect, and any requests of the superintendent to have work or material protected must be complied with."

Tradesmen are naturally careless as to finished work and are liable to pull material through a window and over the sill, thus damaging the sill, or the jambs. In carrying timbers, building scaffolds, and work of like nature, they are

liable to strike and damage carved or other finished work. All work in danger of being thus damaged should be carefully protected, and as this is very frequently neglected, the superintendent should be vigilant in watching for unprotected work and order the same to be taken care of. The responsibility for such damage is often very difficult to locate and the only satisfactory arrangement is to make the general contractor responsible as provided. In case the work is under several contractors and no such clause as the one just quoted is included in the general conditions, it is not a very easy matter to obtain remuneration for such damage, owing to the difficulty of locating the responsibility.

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### THE ARCHITECT AND THE OWNER

**49.** "The architect is the adviser of the owner and represents him on this work, but he is not the owner's agent in the legal sense of the word, except where he may be given special authority by the owner."

There is a misconception as to the duty of the architect that seems to be quite universally held. Many owners expect, and seem to consider it the duty of, an architect employed by them to look after their interests at the expense of, or unfairly toward, the contractor; whereas, the architect's duty is exactly limited to making the drawings and specifications and supervising and directing within the authority given by the contract and specifications.

**50.** Following the general conditions at this point there is sometimes attached a list of the drawings, as for example:

Sheet No. 1. Foundation plan, $\frac{1}{8}$-inch scale
Sheet No. 2. Basement plan, $\frac{1}{8}$-inch scale
Sheet No. 3. First-floor plan, $\frac{1}{8}$-inch scale

and so on, comprising all the general drawings from which the contractors are to prepare their figures.

Instead of numbering the sheets from one up as shown, it is customary in the majority of offices to number consecutively each sheet leaving the office, without reference to the

job, this having a particular number of its own, the same, of course, on each sheet.

Following the list of drawings comes the specification of mason work, carpenter work, etc., with the matter necessary described under appropriate subheadings.

## EXAMPLE OF A SPECIFICATION

**51.** The following specification is a practical example and was used by a practicing architect for the erection of the residence illustrated in Figs. 2, 3, and 4.

Each type of building requires a different specification, but the general method is the same for all, and with the principles in mind no trouble should be encountered in adapting them to the different conditions.

The different radiators, plumbing fixtures, etc. specified are simply given as examples, and it is not intended to suggest that they are preferable to the many other excellent articles on the market.

It will be noted by the student that the articles of this specification are numbered in continuation of the articles of this Section. This has been done to facilitate reference. In an actual specification, these numbers would of course begin at 1.

Although the work under this specification is under four separate contracts, the specification is here placed under one cover as a matter of convenience.

TITLE PAGE

No. 156.
W. No. 2,855.

SPECIFICATIONS FOR A
RESIDENCE

to be erected for John A. Smith, Esq., and to be situated on the corner of A and B Streets in the city of Boston, Mass.

S. W. ROBERTS,
Architect,
325 Trinity Building,
Boston, Mass.

- - - - - - -

NOTE.--This specification includes Excavation, Mason Work, Carpenter Work, Painting and Varnishing, Plastering and Concrete, Tinning and Sheet-Copper Work, Electrical Work, Plumbing, and Heating. See Instructions to Bidders.

FIG. 2

FIG. 3

FIG. 4

INDEX OF ARTICLES IN SPECIFICATION

52. Instructions to bidders
53. Access to work
54. Improper work
55. Disputes
56. Rubbish
57. Samples
58. Tests
59. Extra work
60. Subbidders
61. Schedule
62. Statements
63. Final settlement
64. Laws
65. Permits
66. Loss of life, etc.
67. Proposals
68. Improper work
69. Certificates
70. Insurance
71. Setting out
72. Drawings and specifications
73. Return of drawings
74. Details
75. Correctness of details
76. Changing figures
77. Drawings at building
78. Site conditions
79. Delay
80. Water
81. Heat
82. Telephone
83. Supervision
84. Foreman
85. Protection
86. Responsibility of architect
87. List of drawings
88. Excavating and grading
89. Cellar
90. Foundation, brickwork, etc.
91. Face brick, mortar, etc.
92. Pointing and cleaning
93. Brick below grade, and flue lining
94. Fireplaces
95. Outside cellar steps
96. Wall coating, counterflashing, chases, ash-pits, nogging, etc.
97. Cut stone
98. Concrete floor
99. Old material
100. Plastering first story
101. Plastering second story and laundry
102. Unskilled workmen
103. Defective plastering
104. Bathroom wainscot plaster
105. Framing
106. Cutting
107. Sizes of framing lumber
108. Furring
109. Sheathing paper, shingles and siding
110. Soffit of main cornice and pents
111. Shingles
112. Main frieze
113. Outside steps
114. Gutters
115. Details, exterior
116. Porches, balcony, and bays
117. Porch floors, etc.
118. Balcony and bays
119. Roof strips
120. Priming
121. Cellar door
122. Woodwork, interior
123. Woodwork
124. Wainscot
125. Second-floor woodwork
126. Shelving and drawers
127. Floors
128. Floors scraped and planed
129. Laying finished floors
130. Thresholds
131. Bathroom floors

INDEX OF ARTICLES IN SPECIFICATION—(Continued)

132. Wainscoting dining room
133. Bathroom wainscoting
134. Doors, Old
135. Sliding doors
136. Veneered doors
137. Paneling of doors
138. Mirror doors
139. Double-acting doors
140. Clothes chute and lift doors
141. Windows
142. Cellar windows
143. Architraves
144. French casement
145 Glass
146. Mantels
147. Bookcases
148. Seats
149. Cupboards
150. Stairways
151. Balusters
152. Rear stairway
153. Attic stairway
154. Linen closets
155. Picture molding
156. Cold closet
157. Dumb-waiter shaft
158. Clothes chute
159. Dumb waiter
160. Hot-plate cupboard
161. Hardware
162. Old hardware
164. Range and laundry stove
165. Sheet-metal work
166. Leaders
167. Painting of tinwork and ironwork
168. Ventilating ducts
169. Plumbing, Material, etc.
170. Excavating, freezing, openings for pipes, etc.
171. Gas
172. Water piping
173. Hot-water circuit
174. Boiler
175. Sewer
176. Pipes through roof
177. Painting piping
178. Cast-iron cesspools
179. Lighting fixtures
180. Speaking tubes
181. Water closets
182. Bathtubs
183. Lavatories
184. Kitchen sink
185. Pantry sink
186. Laundry tubs
187. Towel racks and soap dishes
189. Electric wiring
190. Cut-out cabinet
191. Building switch
192. Switches
193. Heating coils
194. Certificate of underwriters
195. Electric bells
196. General painting
197. Exterior painting
198. Shingles, trim, etc.
199. Leaders, exterior varnish
200. Cellar sash
201. Front door and rear door
202. Interior oak
203. Parlor finish
204. Kitchen, pantry, and laundry
205. Oak floors
206. Yellow-pine floors
207. Second-floor woodwork
208. Canvas floor on balcony, Laundry floor
209. Heating, General
210. Heater
211. Covering of heater
212. Smoke pipe
213. Water connection
214. Plate warmer
215. Wall radiators
216. Radiators
217. Total radiation

INDEX OF ARTICLES IN SPECIFICATION—(Continued)

218. Valves
219. Piping
220. Concealed risers
221. Quality of pipe
222. Decorating
223. Pipe covering
224. Cutting
225. Protection of woodwork
226. Material and mechanical work
227. Guarantee of heating contractor

## INSTRUCTIONS TO BIDDERS

**52.** The work on this building will be under separate contracts as follows:

General contract . . . { Excavation; Mason work; Carpenter work; Painting and varnishing; Plastering and concrete; Tinning and sheet copper

Electrical work . . . . Electric wiring and bellwork

Plumbing . . . . . Plumbing complete

Heating . . . . . Heater, steam piping, radiators, etc.

All specialties, materials, or apparatus specified are selected as best adapted to the requirements; should any bidder wish to suggest any changes he must state them in his proposal with proper reasons for such changes. No alterations from materials, etc. specified will be allowed after the contract is let.

# GENERAL CONDITIONS

## THE ARCHITECT AND THE CONTRACTOR

**53. Access.**—The contractor shall furnish suitable and safe means of access for the superintendent or architect to all parts of the work.

**54. Improper Work.**—Any work or material not in conformity with the drawings and specifications must be removed, at the expense of the contractor, upon a written order from the architect or his superintendent, and made to conform with the drawings and specifications.

**55. Disputes.**—In disputes between contractors, or between contractors and owner, the architect is to be the arbitrator, and his decision will be final in the matter.

**56. Rubbish.**—The architect shall have the power to order the removal of rubbish that may accumulate from time to time, if he considers its removal necessary.

**57. Samples.**—Samples of all materials and specimens of finish proposed to be used in the work must be submitted to the architect, and his approval of the same obtained in writing. Only materials equal to such approved samples shall be used in the building.

**58. Tests.**—Any test of cement, stone, steel, or other material desired by the architect must be made under his direction, at the contractor's expense.

**59. Extra Work.**—No extra work shall be paid for except upon the production of a written order from the owner, authorizing the same. The owner will not be liable for any extra work not ordered in this way.

**60. Subbidders.**—The general contractor and other contractors must submit to the architect a list of their subbidders, if any, and only such subbids as are approved in writing by the architect shall be used. The general contractor will be held responsible for all the work of the subcontractors under him.

**61. Schedule.**—A schedule of the quantities and prices on which the contract is based shall be furnished by the contractor for the use of the architect in making out certificates, etc.

**62. Statements.**—Statements showing in detail the amount of work and material furnished by the contractor for the proper period must be submitted when applications for certificates are made. The architect will issue certificates for all payments on the works, and no payment shall be made until certificate for same has been issued.

**63. Final Settlement.**—The contractor, when the work is completed, shall notify the architect that he is ready for a settlement, so that the architect, owner, or others interested may make any statements they wish or submit any bills before the architect issues his final certificate.

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## THE CONTRACTOR AND THE LAW

**64. Laws.**—All work on this building must be done in accordance with the building, sanitary, and other laws in force in the locality in which the building is to be erected, and such laws are hereby made a part of this specification, the same as if written in full herein.

**65. Permits.**—The contractor must give to the proper authorities all requisite notices relative to work in his charge, and he must obtain and pay for all permits, licenses, etc. that may be required by the law, gas and water, or lighting corporations.

**66. Loss of Life, Etc.**—The general contractor shall maintain all necessary guards, railings, watchmen, lights, etc. He shall also be responsible for the loss of any of his tools or apparatus, and shall build temporary sidewalks, roofed passages, etc. that may be required to protect the public.

Each contractor will be responsible for loss of life, damage to adjoining property or to the work of other contractors, caused by himself or his agents and will also be responsible for the loss of any tools or apparatus.

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## THE CONTRACTOR AND THE OWNER

**67. Proposals.**—Proposals should be submitted on blank forms furnished by the architect, and the architect or owner reserves the right to reject any or all bids.

**68. Improper Work.**—The contractor will be responsible for, and must make good at his own expense, any defects, settlements, damages, or injury to the work, arising from improper work or material, which may appear within one year after the work is accepted.

**69. Certificates.**—Any certificate issued, money paid, or occupancy of the building by the owner will not imply the acceptance of work or materials not according to the drawings or specifications; and any such improper work must be replaced within the time of the guarantee mentioned.

**70. Insurance.**—The owner will insure all work paid for by him against damage caused by fire; but all work unpaid for, together with contractor's tools, scaffolding, materials, etc. in the building, shall be entirely at the contractor's risk.

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## THE CONTRACT, DRAWINGS, AND SPECIFICATIONS AND THE CONTRACTOR AND ARCHITECT

**71. Setting Out.**—The general contractor shall verify all lines, levels, and dimensions shown on the survey or on the drawings, and will be held strictly responsible for the correctness of the setting out of the work. He will follow dimensions rather than the scale.

**72. Drawings and Specifications.**—The drawings and specifications are to be considered as cooperative, and any work shown on the drawings and not described in the specifications, or vice versa, or any work obviously necessary to complete the work within the limits of the drawings and specifications, is to be considered as part of the contract, and is to be executed without extra charge in the same manner as the balance of the work. The figured dimensions shall always be taken in preference to the scale.

**73. Return of Drawings.**—The drawings and specifications are the property of the architect, and are to be returned to him on the completion of the building; but necessary copies may be obtained by the contractor at any time for legal or similar purposes in connection with this building.

**74. Details.**—Detail drawings will be furnished by the architect for all work for which such drawings may be necessary. The contractor must apply for such drawings at least two weeks before they will be needed. Any work that the contractor may do without these details will be done at his risk, and if not according to the intention of the architect, must be removed.

**75. Correctness of Details.**—If any of the detail drawings show more expensive work than that indicated on the drawings on which the bids were made or described in the specifications, the contractor must give the architect notice to correct them. If the contractor does not so notify the architect, he hereby agrees to carry out the work as detailed without extra charge.

**76. Changing Figures.**—The contractor must not change figures or otherwise alter the drawings, but must report all errors or discrepancies that he may discover to the architect for correction, before doing any work in which these errors are involved.

**77. Drawings at Building.**—The superintendent or the clerk of the works must keep a complete set of drawings in the office at the building, and any drawings removed for use on the work must be returned to the office at quitting time.

**78. Site Conditions.**—The general contractor must figure on doing everything necessary to carry out his contract in full, taking into consideration all the conditions of the site and the abutting properties.

**79. Delay.**—Each contractor must do his best not to delay other tradesmen, by doing his work promptly and at the proper time.

**80. Water.**—The general contractor must provide for an adequate supply of water for building purposes during the entire progress of the work.

**81. Heat.**—The general contractor will furnish the temporary heat required to dry out the plaster, etc.

**82. Telephone.**—The general contractor shall maintain a telephone at the works for the use of the architect and his assistants.

**83. Supervision.**—Contractor or contractors will give the work their personal supervision, both on the building and in the shop.

**84. Foreman.**—The general contractor shall employ a competent foreman to be on the work at all times. Any workmen who are incompetent must be removed at the request of the architect.

**85. Protection.**—The general contractor must protect both his own work and all the other work and material incorporated in or delivered to the building, and must pay for any damage to same, due to negligence in this respect, and any requests of the superintendent to have work or material protected must be complied with.

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## THE ARCHITECT AND THE OWNER

**86. Responsibility of Architect.**—The architect is the adviser of the owner and represents him on this work, but he is not the owner's agent in the legal sense of the word, except where he may be given special authority by the owner.

## LIST OF DRAWINGS

**87.** The list of drawings for this specification is as follows:

Sheet No. 111. Foundation plan and plan of lot showing location of present building
Sheet No. 112. First-floor plan
Sheet No. 113. Second-floor plan
Sheet No. 114. Third-floor plan
Sheet No. 115. Roof plan
Sheet No. 116. First-floor framing plan
Sheet No. 117. Second-floor framing plan
Sheet No. 118. Third-floor framing plan
Sheet No. 119. Front-elevation framing drawing
Sheet No. 120. Rear-elevation framing drawing
Sheet No. 121. Side-elevation framing drawing
Sheet No. 122. South-side elevation framing drawing
Sheet No. 123. Roof-framing plan
Sheet No. 124. Front elevation and section
Sheet No. 125. Side elevation
Sheet No. 126. South-side elevation
Sheet No. 127. Rear elevation
Sheet No. 128. Stairway details
Sheet No. 129. Mantel details
Sheet No. 130. Detail—trim, wainscot, etc.
Sheet No. 131. Detail—seats, cupboards, etc.

## MASON WORK

**88. Excavating and Grading.**—Excavate for walls and piers as shown in drawings and as directed. The cellar of this building is in the position shown on Sheet No. 111. The cellar is to be excavated 1 foot larger than outside of the walls, to allow room for pointing. Cart away all superfluous dirt and rubbish from the excavation, and from time to time during the progress of the building, as directed by the owner.

**89.** The cellar of present residence will be partly, or wholly, included in the cellar of the new building, and the contractor should look this over before bidding. See Sheet 111.

**90. Foundation, Brickwork, Etc.**—Footings for foundation walls are to be as shown, of good solid quarry stone, averaging 18 inches thick, and 28 inches wide, or 12 inches of concrete 24 inches wide—state price each way. Footings for chimneys are to be made in the same manner. Footings for partition wall in basement are to be

12 inches wider than wall, and 12 inches deep, made of good flat quarry stone. Footings for outside piers and area walls are to be at least 3 feet below grade, and made of good quarry stone. Partition walls in cellar are to be, as shown, of good hard-burned square-edged common brick, laid in good lime mortar made with proportions of three parts of clean sharp sand to one part of freshly burned lime, except as specified in Art. **93.**

**91.** Foundation walls above footings are to be of good sound quarry stone with frequent bond stones, laid in good lime mortar and faced from 6 inches below grade with brick, as shown. Face brick of first story, chimneys, etc. to be Sayre & Fisher's repressed down-draft stretchers laid in flemish bond with common-brick backing, laid in lime mortar. This contractor may use the brick now in old building and on the premises. Brick must be wet before laying, and must be well bonded to stonework. Face brick are to be laid in mortar composed of white sand and lime, one to three; the lime for this mortar is to be run and allowed to stand at least ten days. For all arches and for all brickwork above roof add one shovelful of Portland cement to each hod of mortar.

**92.** Point all face work neatly, and clean down with dilute muriatic acid on completion. Joints to be $\frac{1}{2}$ inch thick, key pointed.

**93.** Brick below grade and for two courses above grade are to be laid in cement mortar.

Line chimney flues from bottom to top with terra-cotta flue lining, extending selected pieces above chimney top as shown.

**94.** Build fireplaces as shown. Build in all hearths the ash traps manufactured by H. W. Covert, 25 W. Broadway, New York City—to be their patent dust-excluding trap. Hearths to be constructed as shown. Furnish and build in each fireplace the throat and damper made by H. W. Covert, New York. Tiling is to be of the color, size, and finish directed by the owner, and is to cost not more than $1 per square foot laid. All tile shall be laid in cement. Furnish and set $\frac{7}{8}$-inch marble facing and hearth in parlor as shown. Build in ash-pit, where shown, 12″ × 16″ wrought-iron doors, with frame and guides.

Fireplace openings are to have $1\frac{1}{2}$-inch wrought-iron frames. Rutty metal wall plugs are to be built in brick joints inside every eighth course, as directed by the carpenter.

**95.** Outside cellar steps are to be of heavy flagging with brick risers.

**96.** Coat outside of foundation wall with a good thick coat of liquid asphalt (not tar), to grade as shown on Sheet No. 124 and as

directed. Build into the chimney 3-pound sheet-lead counterflashing. Build chases for pipes where indicated. Build ash-pit for kitchen range to suit position of grate as directed. Build all necessary relieving arches. Build between both ends of first-story joists with brickwork to level of joists.

**97. Cut Stone.**—All keys and skewbacks, caps for chimneys, door, and window sills, except in basement, are to be Indiana limestone; other cut stone is to be local Laurel Run red sandstone.

**98. Concrete Floor.**—The cellar floor is to be leveled off and tamped to receive a concrete floor. The concrete floor shall consist of 4 inches of Brooklyn Bridge brand Rosendale cement concrete, mixed to the proportions of one part of cement, two of sand, and five of broken stone; this shall have a top layer of $\frac{3}{4}$ inch of Atlas Portland cement, troweled to a smooth surface. The floor is to be pitched to the cast-iron cesspools with bell traps, which will connect to house drain as shown on Sheet No. 111. Soft or damaged spots in concrete are to be replaced. Under the laundry, $3'' \times 3''$ beveled chestnut sleepers, 16 inches in centers, shall be embedded in concrete, level with top, and finished floors laid on the sleepers. Concrete floors in coal bins are to slope to doors with sharp pitch as directed; bottoms of ash-pits to slope to doors also.

**99. Old Material.**—All old material specified to be used will be delivered on premises by owner.

**100. Plastering.**—Plaster all walls and ceilings of first story with two coats of Paragon patent plaster; third coat to be lime, marble dust, and plaster of Paris, troweled to a true and even surface. Angles are to be accurately formed. Total thickness of lath and plaster to be not less than $\frac{7}{8}$ inch.

**101.** Plaster all walls and ceilings of second story and laundry with two coats, the same as just described. Thickness of lath and plaster to be $\frac{5}{8}$ inch; second coat same as specified above.

**102.** Plastering is to be done only by skilled workmen. Any workman deemed unskilled by the architect must, at his request, be replaced by a skilled workman.

**103.** Any defective work must be replaced, no matter from what causes the defects originate. All plastering must be protected. Lath are to be best quality sawed hemlock, free from knots or sap. Lath and plaster soffits of all stairs. No lath are to be put on vertically.

**104.** Plaster on metal lath below wainscot shelf in bathrooms with Keene's cement marked off to imitate tile.

## CARPENTER WORK

### EXTERIOR

**105. Framing.**—The frame of the building is to be built in a thoroughly substantial and workmanlike manner, of good, well-seasoned, straight-grained hemlock. Trimmers and headers are to be doubled and well spiked together, all as shown in the drawings.

Double studs are to be provided at angles and openings. Truss over all wide openings. Double-header and trimmer rafters.

Put 2″ × 4″ diagonal braces between studding, once between floors. Double joists under partitions. Bridge joists once in every 8 feet.

**106.** The carpenter will do all cutting for other trades, and take care to leave proper openings for all piping, etc. Use all old joists possible.

**107. Sizes.—**

| | |
|---|---|
| First-floor joists | 2 in. × 10 in., 16 inches on centers |
| Second-floor joists | 2 in. × 10 in., 16 inches on centers |
| Third-floor joists | 2 in. × 10 in., 16 inches on centers |
| Studding | 2 in. × 4 in., 16 inches on centers |
| Sleepers, chestnut, beveled | 3 in. × 4 in., 16 inches on centers |
| Sills | 4 in. × 8 in., halved at angles and joints, and anchored to wall by bolts |
| Porch joists | 2 in. × 6 in., 16 inches on centers |
| Porch girts | 4 in. × 8 in. |
| Porch rafters | 2 in. × 6 in. |
| Porch-ceiling joists parallel to house | 2 in. × 6 in., 16 inches on centers |
| Main-roof rafters | 2 in. × 8 in., 24 inches on centers |
| Main-hip rafters (two) | 2 in. × 12 in. |
| Ribbons | 1 in. × 5 in. |

**108. Furring.**—Furr all outside brick walls with 1″ × 2″ hemlock strips, 16 inches on centers. Rutty metal wall plugs are to be built into joints of brickwork. The carpenter-contractor will instruct the bricklayer as to the position and spacing of these plugs.

**109. Sheathing Paper, Shingles, and Siding.**—Cover main roof, gables, pents, sides of dormers, and sides of second story, with $\frac{7}{8}$-inch well-seasoned hemlock surfaced sheathing. The sheathing on the main roof is to be 3 inches on the face, laid $4\frac{3}{4}$ inches on centers. Sheathing on the sides is to be put on diagonally. Cover the sides of

the building with approved heavy sheathing paper, lapped at least 2 inches.

**110.** The soffits of pents and the main eaves are to be ceiled with matched-and-beaded yellow pine $2\frac{1}{2}$ inches on face. All brackets are to be bolted to studding with $\frac{1}{2}$-inch bolts and to be as detailed; heads of bolts are to be concealed by "dutchmen."

**111.** Cover the sheathing as shown with best 16-inch cedar shingles, head lap to be $1\frac{3}{4}$ inches. The shingles on the main roof are to be dipped 10 inches in Cabot's stain No. 148. The shingles on the second story are to be dipped 10 inches in Cabot's stain No. 148. The hips are to be finished with Boston hip. The shingles must be carefully and securely put on. Miter shingles neatly at all angles.

**112.** The main frieze shall be made of $1\frac{1}{8}$-inch material with bed moldings as shown. The string-course at second floor shall be made of $1\frac{1}{8}$-inch material with $\frac{7}{8}$-inch facia, etc., as shown; all as per full-size details.

**113.** Outside steps are to have $1\frac{1}{8}$-inch treads built of three slats with an opening of $\frac{1}{4}$ inch between them, and $\frac{7}{8}$-inch risers. The treads are to have nosing and cove. The strings are to be $1\frac{1}{8}$ inches, supported on 2-inch hemlock carriages fitted neatly to stonework. Screen frames $1\frac{1}{8}$ inches as shown.

**114. Gutters.**—Gutters of main roof and porch roof are to be as shown in drawings and details, pitching with slight and uniform grade to leaders as shown, and to be as by detail.

**115. Details.**—Main cornice, rafters, dormers, string-courses, brackets, etc. are to be, as shown and detailed, of No. 2 white pine, free from loose knots or shakes, except front porch, which shall be of No. 1 pine throughout, and columns, which are to be of No. 1 poplar.

**116. Porches, Balcony, and Bays.**—Cornice, pedestals, balustrade, and brackets are to be made as detailed. Upper rail of balustrades will be 3 in. × 5 in., molded and ramped. Lower rail will be 3 in. × 5 in., beveled and molded; balusters $1\frac{1}{2}$ inches square, spaced as directed. Ceil porches with best quality of $\frac{5}{8}'' \times 2''$ yellow-pine ceiling, beaded, matched, and dressed, in full-length pieces. The columns are to be as shown, built of poplar, thoroughly seasoned and free from imperfections of any kind. Caps and bases are to be separate and as shown, all as detailed full size. Posts of rear porch are to be of $7'' \times 7''$ poplar.

**117.** Porch floors are to be of No. 1, $\frac{5}{4}$-inch white-pine flooring, laid in white lead and well driven up. Bases of columns, posts, and

newels are to be well soaked with white lead before setting up. Bases of columns are to be in four pieces with no end wood showing. All finished wood of front porch is to be No. 1 white pine, free from shakes or imperfections of any kind.

Screens under porches to be of punched steel plate of pattern directed by architect.

**118.** Balcony and stairway bay are to be as shown, ceiled underneath in the same manner as the front porch.

**119.** Put strips on dining-room bay roof as detailed, ready for tinner. See Sheet No. 126.

**120.** All window frames, columns, newels, rails, vases, brackets, etc. are to be primed with white lead and linseed oil before leaving the shop.

**121. Cellar Door.**—The cellar door shall be made, as shown, of $\frac{7}{8}$-inch yellow pine, with turn bar and wrought-iron angle to fasten shut, all as detailed.

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INTERIOR

**122. Woodwork.**—Wood used for doors, wainscot, architraves, bookcases, mantels, cupboards, base, picture mold, main stairway, etc., in rooms of first floor, except reception room, kitchen, and pantry, is to be of thoroughly seasoned best-quality quartered oak.

**123.** The woodwork of kitchen, pantry, laundry, and rear stairways is to be of No. 1 yellow pine. Wainscot kitchen and pantry, cap to be as detailed. The bathrooms are to have wooden cap with plain base below and stiles running between. The plaster panels to be of Keene cement, lined to imitate tile joints.

**124.** Wainscot first-floor hall and dining room as detailed. Run chair rail in den as detailed.

**125.** Finished woodwork of second floor and parlor to be best well-seasoned poplar, prepared for painting.

**126.** All shelving and drawers, except fronts, are to be of white pine.

**127. Floors.**—First- and second-floor joists are to be covered with $\frac{7}{8}$-inch rough hemlock flooring; on the rough flooring on the first floor, lay best quality quarter-sawed $2\frac{1}{2}'' \times \frac{7}{8}''$ oak flooring in main hall, reception room, living room, den, and dining room; where *parquetry* is marked, a floor of the design shown, or one equally as expensive, is to be laid, at the option of the owner. Cherry is to be

used in the border. Elsewhere on first floor, and on second floor, lay No. 1 comb-grained yellow-pine $\frac{7}{8}'' \times 2\frac{1}{2}''$ flooring. Attic and laundry are to be floored with No. 2 yellow pine. All joints are to be driven up close, and on first floor, end joints in oak flooring shall be matched.

**128.** First and second floors are to be hand-scraped and planed.

**129.** No finished flooring on first and second floors is to be laid until the plastering is completed.

**130.** All flooring is to be laid without thresholds, except at outside doors, where thresholds of oak shall be inserted.

**131.** Furr up bathroom floors 3 inches and place oak threshold to outside of jamb.

**132. Wainscot.**—Wainscot hall and dining room as detailed. Wainscot kitchen and pantry with No. 2, $\frac{5}{8}$-inch matched-and-V'd yellow pine; all to be 4 feet high. For caps, see Detail. Place a quarter-round at the intersection of the wainscot and the floor.

**133.** Run shelf, as detailed, around bathrooms, with stiles running to base, as detailed, with Keene's cement panels between. See Art. **123.**

**134. Doors.**—The owner will supply all doors marked "old" on the plans, and the contractor shall set same. The outside doors are to have $1\frac{1}{2}$-inch rabbeted jambs and 2-inch oak sills. The jambs are to be rabbeted for screen doors.

**135.** Inside doors are to have $\frac{7}{8}$-inch jambs, with $\frac{1}{2}$-inch stops fastened by Taplin's stop-adjusters. Sliding doors are to be as detailed, and are to be hung on Coburn's door hangers, adjusted and fitted with guides so that they will run smoothly and to the entire satisfaction of the owner. The pockets are to be lined with $\frac{1}{2}$-inch ceiling.

**136.** All doors on the first floor, except those of kitchen and pantry, are to have white-pine cores veneered with oak. The front door is to be as shown and detailed, divided at center, and hung with Dutch door set. The vestibule door is to be as shown, molded the same as the outside door.

**137.** All doors on second floor, also those on first floor in kitchen and pantry, except those indicated on plans as old doors, are to have five horizontal panels, and are to have ogee molded stiles and rails. All other doors are to be molded as detailed with sunk panels and raised molding. Rails and stiles are to be $4\frac{1}{2}$ inches wide, except bottom rail, which shall be 9 inches. All ogee doors are to be of white pine. See Sheet No. 130.

**138.** Closet doors in bedroom *E*, also closet doors in the large front bedroom, are each to have one large panel set with bevel-plate mirror. Stops for the doors are to be backed with felt, to form a cushion for the mirror.

**139.** The door leading from dining room to pantry, also the door leading from kitchen to pantry, are to be hung on double-acting hinges. The door between the dining room and pantry is to be set with leaded glass, as shown on Sheet No. 130. The hinges are to be fastened to a cleat the same width as the door. The cleat shall be screwed to the jamb.

**140.** The doors to the lift and to the clothes chute are to be two-paneled $1\frac{1}{2}$ inches thick. These doors are to be hung over pulleys by approved sash cord and balanced by weights. The door at base of clothes chute is to be self-closing, by weight or spring. The door to cellarway is to be made of two thicknesses of No. 1 $\frac{7}{8}$-inch yellow-pine flooring.

**141. Windows.**—Windows are to be of the sizes shown, and made according to the details on sheet No. 130. Pulley stiles and parting strips are to be of yellow pine. Stops are to be fastened by Taplin's stop-adjusters. Sash on first and second floors and double-hung cellar windows are to be $1\frac{3}{4}$ inches thick. Third-floor sash and single-sash cellar windows are to be $1\frac{1}{2}$ inches thick. Double-hung sash are to be hung over approved pulleys by approved sash chains, and balanced by cast-iron weights. The sash must run smoothly and to the entire satisfaction of the owner. Windows marked *a*, *b*, *c*, *d*, etc. are to be old ones now in present building. See Sheets Nos. 125 and 127.

**142.** Cellar windows shall have $2'' \times 8''$ frames rabbeted for sash. Coal windows shall have door of matched-and-beaded yellow pine, as shown, battened. Single cellar windows shall be hung with hinges at the top.

**143.** Inside and outside architraves are to be as shown on Sheet No. 130 and detailed.

**144.** French casement in rear hall to be as indicated and detailed.

**145. Glass.**—In first and second stories, the doors are to have selected American plate glass, free from imperfections of any kind. All other glass is to be selected grade double-thick American, well tacked and puttied. Leaded glass windows are to be furnished by the owner—sash to be sent to and from the manufacturers and set at the expense of the contractor.

**146. Mantels.**—The six mantels are to be built and set up as shown and detailed. The tiling is to cost $1.50 per square foot and is

to be selected by the owner. The carpenter will frame for support of hearths. See Sheet No. 129.

**147. Bookcases.**—Bookcases are to be as shown on Sheet No. 130 and as detailed. Shelves are to be 9 inches deep.

**148. Seats.**—The seats in sitting room, den, landing, and bedroom are to be as shown and detailed. See Sheet No. 131. The seats are to be hinged with $2\frac{1}{2}'' \times 2\frac{1}{2}''$ bronzed-steel butts, and should be pitched back slightly.

**149. Cupboards.**—The cupboards are to be as shown on Sheet No. 131. Build in dripboard and work table, as shown, in pantry and kitchen, the boards to be of ash $1\frac{1}{8}$ inches thick. Cupboard doors throughout the house are to be $1\frac{1}{8}$ inches thick; shelves, $\frac{7}{8}$-inch white pine.

**150. Stairways.**—The main stairway is to be as shown on Sheet No. 128, and shall be of clear, well-seasoned, quartered oak. All to be as detailed, sizes to be as follows:

Rails . . . . . $3\frac{1}{2}$ in. $\times$ 4 in., molded, ramped, and eased
Treads . . . . . $1\frac{1}{8}$ inch, with cove under
Risers . . . . . $\frac{7}{8}$ inch

**151.** Balusters are to be $1\frac{1}{2}$ inches turned and dovetailed into treads. Stairs are to be supported on sound hemlock carriages not more than 12 inches on centers. Treads and risers are to be housed into each other, and securely nailed to carriages. Paint the backs of all treads and risers.

**152.** Rear stairways to second and third floors and to cellar are to have yellow-pine treads and risers with plain $\frac{7}{8}$-inch wall string let into treads and risers for cellar stairs, and regular base for second-floor stairs—treads $1\frac{1}{8}$ inches, risers $\frac{7}{8}$ inch. Treads are to be housed into risers. All supported on hemlock carriages. Cove under nosing of treads. Run 3-inch, round, yellow-pine, hand rail down the long flight of cellar stairs.

**153.** Place poplar newels and plain balustrade at the head of attic stairs as shown.

Stairways shall be built by skilled stair builders, and shall be well constructed in every respect to make a neat substantial job, according to drawings and specifications. The stair builder will take all measurements for this work at the building and not from the architect's drawings.

**154. Linen Closets.**—Build cupboards in linen closets, as shown in plans, of clear white wood, except drawers and shelves which shall be of white pine.

Provide $\frac{7}{8}$-inch shelves substantially supported. Drawers, $1\frac{1}{8}$ inches, plain front, substantially constructed. Counter shelf shall be 3 feet from floor, with three drawers below. Cupboards are to extend to ceiling as shown in pantry, with molding on top. Doors are to be $1\frac{1}{8}$ inches, paneled, as detailed, with ogee-molded stiles and rails. Place two $\frac{7}{8}$-inch white-pine shelves and hook strips in all closets as directed.

**155. Picture Molding.**—Place picture molding, satisfactory to the owner, in all rooms of first and second stories, as directed.

**156. Cold Closet.**—Place three tiers of $\frac{7}{8}$-inch white-pine shelves, substantially supported, in cold closet, as shown in plan.

**157. Dumb-Waiter Shaft.**—Build dumb-waiter shaft with weight pocket, as shown, 20 in. × 24 in., and extending from the third-floor joists to the kitchen, and line with $\frac{5}{8}$-inch yellow-pine ceiling. Fasten with screws a number of short pieces of ceiling over the weight pocket near the first-floor opening, so that the weights may be accessible.

**158. Clothes Chute.**—Construct clothes chute in the same manner as the dumb-waiter shaft, just described, without pocket.

**159. Dumb Waiter.**—Supply and set up complete, in shaft, a sheave dumb waiter, manufactured by Morse, Williams & Co., of Philadelphia, capacity 25 to 40 pounds, to be left in perfect working order on completion of building.

**160. Hot-Plate Cupboard.**—Build hot-plate cupboard under work table in pantry, as directed.

**161. Hardware.**—The contractor shall furnish the following finished hardware. The owner will furnish all other hardware for doors, windows, cupboards, and drawers. The contractor will apply all hardware.

Window and clothes-chute, and dumb-waiter door weights, and pulleys, together with approved sash chain. Two 3″ × 3″ bronzed-steel butts for each casement window. Taplin's stop-adjusters; six to each window and eight to each door on first and second stories, to match other hardware. Two $2\frac{1}{2}$″ × $2\frac{1}{2}$″ steel butts for each single cellar window. Bolts for penthouse brackets. Casement catches for each single cellar window. Hook and eye to fasten open for each single cellar window. Bronzed brackets for hand rails. Coburn's door hangers. Sheet-iron doors for ash-pits. All other ironwork or finished hardware required to carry out these specifications and the drawings, and not covered under the head of Finished Hardware, as just specified, are to be furnished by the owner.

**162.** The contractor will remove all old hardware from old doors and windows and make ready for new hardware.

## SHEET-METAL WORK, PLUMBING, AND GAS

**163.** The following articles of the general conditions are to be considered as a part of the plumbing specifications: **55, 56, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 73, 74, 75, 77, 78,** and **85.**

**164. Range and Laundry Stove.**—The owner shall supply a range that shall be put up and connected by the plumbing contractor, who shall also provide the piping necessary to connect the stove with the smoke flue. He shall further provide a sheet zinc lining behind the stove extending to cap of wainscot, and a neat iron floor board under the stove. The owner will supply a stove in the laundry, which the plumbing contractor shall connect to smoke flue.

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### SHEET-METAL WORK

**165.** Line hot-plate cupboard in pantry with tin and asbestos paper. Provide 3-pound sheet counterflashing, and see that it is built into chimneys as shown. Porch roof, roofs of bays, valleys, gutters, and flashings are to be of McClure's 40-pound charcoal iron XXX plate tin, properly soldered and nailed. Extend the tin on porch roofs out over the crown molding of cornice and finish with a blind joint. Flash around all dormers, north chimneys, where pipes go through the roof, and wherever necessary to make a water-tight job, leaving all in perfect condition and to the satisfaction of the architect.

**166.** Provide and set up in a substantial manner $3'' \times 4''$ shallow corrugated galvanized-iron leaders with rain-water heads and straps where shown on elevations and according to details. Connect the leaders to the sewer as indicated on the plan, using cast-iron pipe to 18 inches above grade. Cement the galvanized leader in the cast-iron pipe.

**167.** All tinwork and ironwork are to have three coats of Princess metallic paint. Paint both sides of roofing tin before it is laid, and apply two coats of paint after the tin is laid. The last two coats are to be put on by the painter. This provision does not apply to leaders, which will be painted by the painter as afterwards specified. See Art. **199.**

The cresting is to be of galvanized iron as shown and detailed.

**168.** Provide and put in two $3'' \times 10''$ tin ventilating ducts extending from bathrooms through the roof. Make provision for pockets for resistance coils, as shown on the drawings, and provide each opening with a plain bronzed lattice register.

PLUMBING

**169. General.**—All joints in cast-iron pipe are to be calked with oakum and lead. Horizontal branches in waste pipes and soil pipes are to have a fall of at least $\frac{1}{4}$ inch to the foot. All piping is to be neatly and securely fastened to beams or walls. Cast-iron pipes are to be painted one coat of tar paint. Joints in lead pipes are to be wiped. Joints between galvanized-iron pipes and lead pipe are to be made with brass ferrules, wiped to lead pipe and screwed to the galvanized iron. All joints in galvanized-iron pipe or wrought-iron pipe are to be made with red lead. All joints in terra cotta are to be made with Portland cement. Vent pipes, also hot- and cold-water pipes, except as otherwise specified, are to be of best quality galvanized-iron pipe. All branches at sinks and basins are to be extended for air chambers. All cast-iron pipe is to be of the grade known as *extra heavy*. Gas pipe is to be standard wrought iron with malleable-iron fittings.

**170.** The plumber shall do all necessary excavating for his work, and obtain and pay for all permits, etc. The piping is to be run as direct as possible, and, where necessary, protected from freezing. The plumber must see that all openings required for his piping are left in the walls when they are being built. This is important, and any extra work required to cut holes that should have been left shall be at the plumbing contractor's expense.

**171. Gas.**—Tap the main in street and run a $1\frac{1}{4}$-inch gas pipe to the kitchen, with outlet for gas stove. Put in meter connections and stop-cock.

**172. Water Piping.**—Tap the street water main. Connect tap and house supply by $1\frac{1}{2}$-inch galvanized-iron pipe. Set a $1\frac{1}{4}$-inch lever-handle stop-and-waste cock in an accessible place. From the stop-cock, run a $1\frac{1}{4}$-inch line to the bathrooms, kitchen, pantry, laundry, lavatory, boiler, etc., grading the system so that it will drain when the water is shut off. Each riser is to have a gate valve placed near the water main. Place hose connections at front and rear of house, where directed by the owner.

**173.** A hot-water circuit is to be put in from the range boiler to the bathrooms and lavatory, from which branches are to be taken off to the various fixtures, insuring hot water at once when a faucet is opened.

**174. Boiler.**—Supply and set on a neat boiler stand, a 60-gallon galvanized-iron boiler. Connect the ground-brass couplings on the boiler with the waterback in the range, through $1\frac{1}{4}$-inch heavy

brass pipes, having lever-handle stop-cocks and sediment pipes connected with a waste pipe. Supply the boiler with water through a $1\frac{1}{4}$-inch galvanized-iron pipe and run a $1\frac{1}{4}$-inch galvanized-iron pipe to bathrooms, kitchen, laundry, and pantry sink as just described.

**175. Sewer.**—Connect the house sewer to the sewer in street by 6-inch terra-cotta pipe, and extend it to within 6 feet of the outside wall of the building. Connect the house sewer to the house drain and extend it as shown in the drawings. Place an intercepting trap, where shown, in a brick box and provide the brick box with an iron cover. The trap is to have brass screw-cap clean-outs. Put a clean-out at rear end of line. Run vent lines of the sizes shown, and connect them to traps of fixtures, as shown. Connections to the stack are always to be above the highest point of the fixture vented.

**176.** Extend all soil and vent pipes above the roof. Test the system in the presence of the architect, by smoke and water tests.

**177.** All exposed piping in basement is to be painted two coats of oil paint by the painter. All other exposed piping above basement not nickel plated, also the hot-water boiler is to have two coats of paint as directed.

**178.** Place cast-iron cesspools with bell traps in cellar floor and connect the cesspools to the sewer as shown.

**179. Lighting Fixtures.**—Not included in this contract.

**180. Speaking Tubes.**—Run speaking tubes from the kitchen to the upper rear hall, and provide them with nickeled mouthpieces and whistles.

**181. Water Closets.**—Supply and set up complete, as shown on Plate 4 K of Standard Manufacturing Company's catalog (shown in booklet entitled, "Sanitation"), three Regent roll-rim siphon wash-down water closets, plain vitro-porcelain bowl, with plain oval seat and cover attached; nickel-plated cast-brass hinges; round-corner tank with bevel top, and pearl-head push button; nickel-plated $\frac{3}{8}$-inch supply pipes; flush connections, spun cups, and bolts. Connections to soil pipes are to be made with brass floor flanges and rubber gaskets. All of these closets are to have woodwork in high Dutch oak finish.

**182. Bathtubs.**—Supply and set up complete, as described, two Minerva bathtubs manufactured by the L. Wolf Manufacturing Company, and as shown on Plate F 1,735, 1900 catalog. Tubs are to be 5 feet 6 inches long, finished zinc-white outside, with gold bands, nickel-plated shampoo, water and supply pipes. Legs are to be painted at the factory, and of the same finish as the outside of the tubs. Any

damage must be made good by plumber. No floor slabs. Supply and waste fittings to be Fuller pattern. Tubs must be accompanied by a factory guarantee.

**183. Lavatories.**—Supply and set up, where indicated, two of the J. L. Mott Iron Works imperial-porcelain 30″ × 24″ lavatories, Class A; imperial porcelain back and legs, nickel-plated adjustable trap, with nickel-plated supply pipes; all complete, as shown and described on Plate 4,005 R of their catalog. Set these lavatories away from corners and not as shown on the plan. Consult architect.

Supply and set up in lavatory on first floor a 14″ × 17″ earthenware bowl, with overflow; fasten to corner slab as indicated; slab to be countersunk and fitted with 10-inch molded back slabs; supply through nickel-plated Fuller basin cocks; waste through nickel-plated pipes and trap; fit with nickel-plated chain, stay, and stopper. All neatly put up and well supported. All exposed metal nickeled.

**184. Kitchen Sink.**—Supply and set up, where indicated, one imperial-porcelain roll-rim 36″ × 23″ × 7″ sink, Class B, with nickel-plated simplex standing waste; bronzed-iron legs; imperial-porcelain back, 18 inches high, nickel-plated $\frac{3}{4}$-inch Fuller pattern, extra-large faucets, and nickel-plated brass 2-inch trap with pipe to floor. Carpenter shall make and fit drain board. Supply and set in place imperial-porcelain soap dish, all to be as described and shown on Plate 834 R of the J. L. Mott Iron Works catalog R.

**185. Pantry Sinks.**—Supply and set up as indicated in the plan, two 14″ × 20″ square copper sinks (Plate 561 S, Standard Manufacturing Company's catalog); supply through nickel-plated compression pantry cocks, Fuller pattern; waste through cast-iron trap and galvanized pipe to floor; trap and pipe to be painted as directed. Nickel-plated floor flanges.

**186. Laundry Tubs.**—Supply and set up where shown in laundry, a set of three Colonial roll-rim washtubs, with bronzed-iron adjustable legs, size No. 1, with ash cap and one-ringer base, all complete, as shown on Plate 904 R of the J. L. Mott Iron Works catalog, Class A, with $1\frac{1}{2}$-inch brass waste, 2-inch trap, $\frac{5}{8}$-inch Fuller pattern faucets, and brass stoppers.

**187. Towel Racks and Soap Dishes.**—Supply for each bathroom and for lavatory, nickel-plated towel racks 18 inches long, as shown on Plate 179 R of the J. L. Mott Iron Works catalog.

Supply each bathtub and basin with the soap dish shown on Plate 202 R, Mott's catalog R.

## ELECTRIC LIGHT AND BELLS

**188.** The following articles of the general conditions are to be considered as a part of these specifications: **55, 56, 58, 60, 61, 62, 63, 64, 66, 67, 68, 69, 70, 77, 78,** and **85.**

**189. Wiring.**—All electric-light wires are to be supported on non-combustible insulators, with wires of opposite polarity, at least 10 inches apart. No staples are to be used, and the wire is not to be run through plaster, unless in American circular loom.

Put up just inside of the outside wall a suitable switch, with fuses properly protected from fire. The wire used is to be the best Bishop or J. A. Roebling's Sons Company rubber-covered. No wire smaller than No. 14 B. & S. gauge will be permitted. The necessary joints are to be adequately insulated, and all wires are to be kept away from piping as far as possible. Extend wires to outlets indicated, and bring out through porcelain outlet blocks or bushings. Place cut-out cabinet where directed in second-floor hall and fit door with lock and key.

**190.** Approved fuse-holder panel board in cut-out cabinet is to be of slate, and removable. The jambs and the back of the box are to be of $\frac{1}{2}$-inch slate, furnished and set up by the electric-wiring contractor. The door is to be paneled and lined on inside with asbestos board at least $\frac{1}{8}$ inch thick, and fitted with lock and key; woodwork is to match the other doors. Circuits must be tested before the casing is put on the panel board or the door hung.

**191.** Place in attic on slate base, well supported, an approved building switch, according to requirements of the National Electrical Code; this switch is to be well protected from fire by fuse, to the satisfaction of the architect. The main cut-out is to have G. E. enclosed fuses.

**192.** Provide single-pole switches, with faces finished to match other hardware, controlling lights in hall, living room, parlor, den, and dining room. Also provide a switch at the head of the cellar stairs, controlling light in laundry, and one in the upper hall, controlling light in main hall; also one in the main hall, controlling front-porch light.

**193.** Place resistance coils in ventilating ducts in bathrooms, with push-button switches to control same.

**194.** All work is to be done according to the rules of the Board of Underwriters, and payment is to be made only upon presentation of their certificate of approval to the owner.

**195. Electric Bells.**—Place bronzed push buttons at front door, bedroom *E*, and front bedroom, and floor button in dining room, and connect by best copper wire, insulated by waxed cotton, to approved bell in kitchen. The batteries in the circuit are to be sal ammoniac, placed upon a strong shelf in an accessible place in the cellar. Supply and put in place on a neat board, an approved bell, with neat annunciator with four drops properly designated by name, connected to front-door push button.

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## PAINTING

**196.** The following articles of the general conditions shall be considered as part of the painting specifications: **58, 59, 60, 61, 62, 63, 64, 67, 68, 69, 70, 81, 82, 84,** and **85.** This specification is intended to include the painting and finishing of all woodwork and other work throughout the building usually painted or finished, and all work not specially mentioned herein must be finished or painted as if specially mentioned to conform with the rest of the work as specified.

Prime all finished work, window frames, brackets, columns, etc., at the shop with pure boiled linseed oil and white lead tinted as directed by architect. Shellac all knots for painted work, and putty all nail holes, etc.

All varnish used on this job is to be Chicago Varnish Company's, brought to the building in sealed packages; thinning with turpentine will be allowed only sparingly.

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### EXTERIOR

**197.** See Sheet-Metal Work, Art. **167**; see Plumbing, Art. **177.**

**198.** Shingles are to be stained as before specified. The rest of the exterior woodwork, except ceiling, is to be painted three good coats of lead and oil; color as directed.

**199.** Leaders are to be painted two coats of color as directed; ceilings of porches, soffits of balcony, stairway, bay, and main cornice are to have two coats of spar varnish.

**200.** Cellar window sash and door are to have two coats of paint.

**201.** The front door is to have three coats of exterior oak varnish and the rear door is to be painted the same as the exterior.

INTERIOR

**202.** All of first-story oak is to have one coat of paste filler, stained as directed, followed by three good coats of "Shipoleum" rubbed to egg-shell gloss with raw linseed oil and pumice stone. The first coat shall be rubbed with sandpaper, and the second and third coats shall be rubbed with pumice stone and oil.

**203.** The parlor woodwork is to be stained as directed, followed by a coat of shellac and three coats of "Shipoleum," rubbed as just stated (Art. **202**) to egg-shell gloss.

**204.** Kitchen, pantry, and laundry woodwork is to have one coat of shellac, followed by two good coats of "No. 6", rubbing to natural finish.

**205.** Oak floors are to be filled with Chicago Varnish Company's paste filler, using 1 quart of "Supremis" floor finish to each gallon of filler, followed by three light coats of "Supremis" floor finish rubbed to egg-shell gloss, as just described for oak finish.

**206.** Yellow-pine floors, except in laundry, are to have one coat of filler as just described, followed by two coats of "Supremis" floor finish.

**207.** Second-floor woodwork is to have three good coats of white lead and pure linseed oil, followed by two coats of white "Enamelite."

**208.** The canvas on the floor of the balcony is to have three good coats of pure white lead and linseed oil. The floor of the laundry is to have two good coats of deck paint; color as directed.

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HEATING

**209.** The following articles of the general conditions are to be considered as a part of these specifications: **55, 56, 58, 59, 60, 62, 63, 64, 67, 68, 69, 77,** and **85.** It is understood that the plans that accompany these specifications, and in themselves constitute a part of same, are intended to cover a complete low-pressure gravity system of steam heating, and anything omitted in the specifications that appears on the plans, or vice versa, shall be included in the estimate, as if shown and mentioned in both.

**210. Heater.**—Furnish and set up in boiler room, as indicated in the plans, on suitable brick or cement foundation, one No. 528 Henderson Thermo Steam Heater, having a rated capacity of 850 square feet. (See catalog of The Prizer-Painter Stove & Heater

Company, Reading, Pa.) The heater is to be furnished with a complete set of trimmings, consisting of steam gauge, water gauge, automatic damper regulator, safety valve, blow-off cock, and fire-tools, which consist of slice bar, hook, ash hoe, and steel-wire flue brushes.

**211.** After the heater has been set up and thoroughly tested, it shall be covered with asbestos cement to a thickness of 1 inch; same is to be applied while heater is under fire, and is to be put on in at least three coats, each coat to be permitted to become thoroughly dry before the next coat is applied. After applying the finishing coat, it shall be rubbed smooth with a piece of wet rubber and then the entire surface shall be covered with 6-ounce canvas, the same to be put on with good flour paste.

**212. Smoke Pipe.**—Connect the heater to the smoke flue through a 10-inch galvanized-iron pipe of 20-gauge iron, the same to be fitted close within the smoke-pipe opening and also on to the smoke ell, which is furnished with the heater. This smoke pipe is to be provided with a damper.

**213. Water Connection.**—The contractor shall connect the water supply to the heater through a $\frac{1}{2}$-inch galvanized-iron pipe, the same to be provided with a good stop-cock conveniently located near heater so that the water glass can be watched while filling is being done. Provide also on the lowest point of return connection a 1-inch blow-off cock, the same to have a brass hose thread on the outer end. This blow-off is to be in addition to the one furnished with heater.

**214. Plate Warmer.**—Place in warming closet in pantry one plate warmer; the same to be constructed of 1-inch iron pipes connected to two 5-pipe branch tees, the lower one being provided with a 1-inch back outlet. This coil is to be made in such a way that it will form two shelves, having a space of 10 inches between the lower and the upper shelves, the end connection to be made through 1-inch elbows with an 8-inch right-and-left nipple between. The coil is to be supported on wooden blocks, which shall be raised 2 inches from the floor, and is to be provided with a facing of tin on the top of said blocks to permit free circulation of the air through the entire coil. On the top of each row of pipes, provide a stamped-metal shelf of the size necessary to cover the entire coil. The owner will provide the latticed doors and will also line the inside of the closet with asbestos paper and tin. A valve to control this coil is to be located in the basement and shall be a 1-inch straightway valve.

**215. Wall Radiators.**—Place in lavatory on first floor and in the two bathrooms on second floor, radiators of the Colonial type, made by the American Radiator Company. The radiators are to be

secured to the walls with the regular brackets. Steam connections are to be made at the lowest end of radiators and in such a way that the single-pipe connection will also take care of the condensation within said radiator.

**216. Radiators.**—Place in living room on first floor one four-column Louraine radiator 18 inches in height. In parlor and den, place 18-inch three-column Louraine radiators. In dining room, vestibule, hall, and all second-floor rooms (bathrooms excepted), place 38-inch plain Reliance radiators, same being manufactured by The Pierce, Butler, & Pierce Manufacturing Company, Syracuse, N. Y.

**217.** The total amount of radiation in connection with this system is to be not less than 557 square feet.

**218. Valves.**—Each radiator is to be connected to the system of piping through a nickel-plated union wood-wheel Jenkins disk-radiator valve; the same to be of a quality equal to those manufactured by The Pennsylvania Engineering Company, Philadelphia, Pa. Place on each radiator, and at the extreme end of main, an automatic air valve of a quality equal to the Ball Joint Royal air valve, manufactured by The Pennsylvania Engineering Company, or the Monash Yonker valve.

**219. Piping.**—The system of piping is to be the single-pipe, complete-circuit, low-pressure, gravity system, and the main supply pipe shall be 3 inches in diameter, the same to have an easy grade of not less than 1 inch in 20 feet, or more if the height of basement will permit. All connections are to be taken off at an angle of 45°, using a close nipple and a 45° elbow. All horizontal pipe connecting to risers and first-floor radiators shall be one size larger than the vertical pipe to which it is connected. The steam main is to be secured to joists overhead by means of ring hangers of a grade equal to the Ball Joint hanger manufactured by The Pennsylvania Engineering Company. Where pipes pass through floors or partitions in exposed places, they shall be provided with nickel-plated floor plates and ceiling plates. All joints are to be made with clean-cut threads screwed together, iron to iron.

**220. Concealed Risers.**—The risers leading to second-floor rooms and passing through the principal rooms on first floor are to be concealed in recesses in walls. These slots, or recesses, will be provided by the owner, and shall be lined with asbestos paper in such a way that it will form a dead-air space from the bottom to the top. The risers shall also be covered with asbestos paper, to be wrapped around the pipe after being saturated with water. At the termination of three of these risers on the second floor, the contractor shall place

a tee and the upper opening shall be provided with a plug, so that extension can be made to the third floor at any time by the owner, if so desired.

**221.** All pipe is to be of the best-quality wrought iron, and all fittings are to be of clean gray cast iron, heavily beaded.

**222. Decorating.**—All radiators and exposed piping above the first floor are to be painted with a good quality of radiator enamel or first-quality bronze of a tint selected by the owner or the architect.

**223. Pipe Covering.**—Cover all pipes in the basement, laundry excepted, with $\frac{3}{4}$-inch three-ply air-cell asbestos covering of a quality equal to the covering manufactured by The Keasby & Mattison Company, of Ambler, Pa. All fittings are to be covered with magnesia-asbestos cement and an outer covering of 6-ounce canvas. The covering is to be secured with metal straps placed every 18 inches, to be neatly applied and to have a uniform finish when completed.

**224. Cutting.**—Any carpenter work necessary, such as framing or cutting through floors or partitions for the passage of pipes, is to be done at the owner's expense and under the direction of the heating contractor.

**225. Protection of Woodwork.**—All woodwork in contact with pipes is to be properly protected with a facing of tin, provided and securely fastened in place by the heating contractor.

**226. Material and Mechanical Work.**—All the material used in the construction of this apparatus shall be new and of the best quality. The work is to be installed by skilled workmen under the supervision of the heating contractor or a competent foreman, and on completion it shall be fired up and tested in the presence of the owner or the architect and left in a first-class condition, ready for use.

**227. Guarantee.**—The contractor shall guarantee his work in every particular; that when completed it shall be free from mechanical defects and noiseless in operation, and that after the apparatus shall have been accepted by owner, if any part thereto shall fail to accomplish the guarantee herein contained by reason of any defect in workmanship or material, the contractor shall remedy such defect at his own cost within a reasonable time after being notified of same.

The term "defect" as used here shall not be construed as embracing such imperfections as would naturally follow improper treatment, accident, or the ordinary wear and tear of use.

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# SPECIFICATION-WRITING MEMORANDA

## BUILDING ERECTION, CONSTRUCTION, AND EQUIPMENT

**1. Introduction.**—The writing of specifications in which are described all the necessary data pertaining to the erection, construction, and equipment of buildings is a very important matter. The following memoranda are for the assistance of the writer of specifications, enabling him to find, without delay, much necessary data stated in a brief and concise manner.

### EXCAVATION AND MASONWORK

**2. Depth of Footings.**—The depths of footings should be regulated by the nature of the soil and the depth to which the frost penetrates in the locality, and should be shown on the drawings. The contractor should go deeper if the soil proves unsafe to build on at the depth specified, and the specifications should so provide. The contractor would of course receive extra compensation for such work and should notify the superintendent when such an occasion arises, in order that a record may be kept of the extra amount of excavation that is done.

**3. Width of Trenches.**—The width of trenches, etc. for masonry should be not less than 8 inches wider each side than the actual dimensions of walls or piers, in order to allow proper inspection and so that the mason may be able to properly point the outer side of the wall as it is built. The widths of trenches are usually governed by the widths of the footings, which are proportioned according to the weight they are to carry.

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**4. Water in Excavations.**—If water is encountered in any quantity, provision should be made to lead it away from the walls by means of terra-cotta drains. This is very important and the strength of the foundations is often greatly dependent on this precaution. On the other hand, water is often necessary for the stability of the soil (as, for example, a saturated sand bed) and it would be disastrous to drain it.

**5. Foundation Beds.**—When **rock** suitable to build on is encountered, it should be stepped in level beds where necessary to receive the walls, and all hollow spots should be filled with concrete.

**Sand** forms a good foundation bed if kept dry; and if confined laterally, a wet sand bed is safe for building.

**Clay,** when hard and dry, is usually a good bed, but if damp and on a slope, it is treacherous unless it is confined, as it is liable to slide.

**Gravel** forms a good foundation bed; is easily leveled, and if reasonably dry, has a large bearing power.

**Made ground** should never be trusted to carry any great amount of weight, and, if it is possible, the excavation should be carried through this soil to a firmer one; but if this is not possible, the walls should be carried on thick concrete footings that are so spread as to widely distribute the weight.

**6. Uniformity of Foundation.**—Foundations should be so constructed that the pressure on the soil under footings shall be well within the safe-bearing power of the soil at all points; or if this is impossible, so that the settlement will be uniform at all points. Great care should be bestowed on the examination of the bottoms of the trenches, in order that soft spots, etc. may be removed and the holes filled with concrete. If a very large spot should occur in an otherwise good foundation, it should be spanned with a concrete lintel or a brick arch springing from the abutting footings.

**7. Sheet piling** is used in soft and treacherous soils to keep the trenches open during the laying up of the walls. These piles are either of wood or of steel, are flat, and are driven side by side against the bank of the excavation, forming a continuous partition to prevent the spread of the soil. Wooden sheet piles are either jointed by butting or are matched. Steel piles are of different forms with or without calked joints.

**8. Footing Stones.**—The footing stones should be as large as possible and should be laid on their natural beds. They should be well bedded in cement mortar, and as the footings are under the greatest pressure, they should be of the hardest stone obtainable.

**9. Common Tests for Stone.**—Stone is commonly tested for compression and absorption. For compression, the crushing value is seldom less than $2\frac{1}{2}$ tons and sometimes reaches 20 tons per square inch. The crushing value and weather-resisting qualities are usually greater in stones of a crystalline character than in those of an amorphous character; and the bearing power is greatest when laid on the natural bed. The safe working values for these stones are from one-tenth to one-thirtieth of the values just given.

A simple test to determine the crystalline properties of stone can be made by placing a few chippings in a glass of clear water. If, after being agitated briskly for a few moments, the water shows no muddiness but remains perfectly clear, it may safely be inferred that it is a good crystalline stone and is suitable for building purposes, provided its resistance to compression is ample and its absorption value is not excessive.

**10. Durability of Stone.**—The durability of stone can usually be judged by the foregoing tests, but observation of actual examples in buildings of such stones as are to be used is very essential to safe results.

The atmosphere of large cities often contains gases that are due to bituminous-coal smoke and other vapors from large manufactories. These gases have a great affinity for water, and when combined with rain water, or mist, they form very weak acids that have a detrimental effect on marbles and limestones. Before using such stone in localities where these gases are given off, observations should be made to determine whether such stone has already been used there, and if so, to find out the age and condition. The finish of the different surfaces of the stonework used in a building should be clearly specified.

High temperatures will permanently injure almost all building stones, but up to 800° F. the average good building stone will not be materially injured.

**11. Concrete Footings.**—The depth of concrete footings should not be less than 8 inches and should be proportioned in area according to the weight to be placed on them.

**12. Aggregates for Concrete.**—The nature and relative amount of aggregate used for concrete has much to do with the final strength of the mixture. Very hard or dense stones are not so good as those of moderately porous nature. Broken stone is better than gravel. Slag, brick, and clean cinders are better where fireproof qualities and lightness are desired, but the slag should be entirely free from sulphur or unburned particles of coal. Slaty coal should not be used for aggregate where fireproof qualities are desired.

**13. Safe Loads on Concrete.**—The average safe loads per square foot for Rosendale- and Portland-cement concrete, 12 months

old, composed of one part cement, three of sand and six of broken stone, is as follows: Rosendale concrete, with stone aggregate, 9 to 15 tons; Portland concrete, with slag or stone aggregate, 15 to 25 tons.

**14. Ramming Concrete.**—Concrete should be well rammed immediately after being placed in position, whether used for floors of buildings or for footings. The compression thus obtained insures greater density and strength. This ramming, however, should not be too prolonged, or it will affect the strength of the concrete.

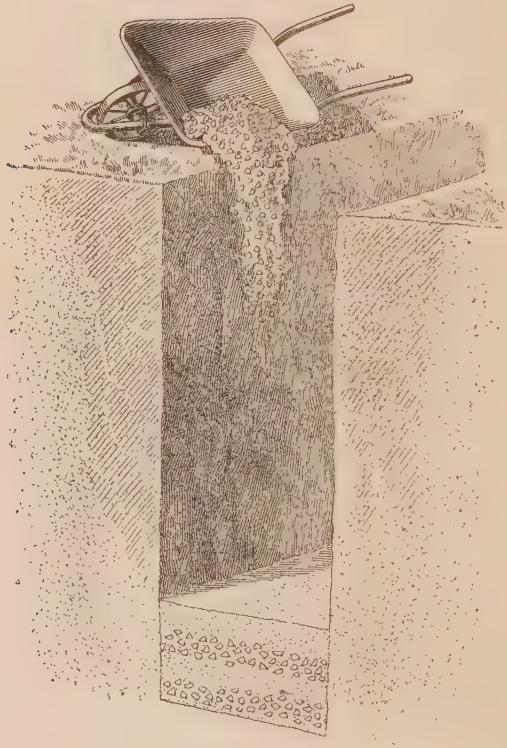

FIG. 1

**15. Placing Concrete for Footings.**—Concrete should not be thrown from a height greater than 4 feet, as the larger and heavier portions, or aggregate, thereby become separated from the sand and cement, and the concrete will be uneven in its composition and strength. In Fig. 1 is shown how such concrete would be composed. A wooden incline should be used under such circumstances

**16. Precautions for Using Cement Concrete.**—Cement concrete should be used as soon as mixed, and in hot weather it is a good plan to sprinkle the concrete lightly from time to time—just enough to keep the surface wet. This will retard the shrinkage somewhat and prevent surface cracks.

**17. Cement Qualities.**—Cements are usually tested for their setting and hardening qualities, strength under tension, and compression at different ages, and also for the relation of these qualities to specific gravity and fineness.

**18. Concrete foundation walls** should be built between matched board framing, strongly made, to prevent bulging under the weight of the concrete, and should be laid in courses of not less than 6 inches nor more than 12 inches at one time. The upper surface of each course should be left rough, to form a key for the succeeding course, and if allowed to set and dry before the upper layer is placed, it should be made wet, as already described. Concrete makes a much stronger wall than one of brick or stone of the same thickness. The surface may be appropriately molded or plastered.

**19. Concrete-Floor Construction.**—Concrete-floor construction consists of reinforced slabs of concrete placed between steel or concrete beams. The reinforcement is obtained in various ways by steel of different shapes being so placed as to take up the tension and assist in resisting the shearing stresses of the mass. The selection of a type of concrete-floor construction is a rather difficult matter, as there are a great many good systems, but any floor that is allowed by the Building Department of New York City may be accepted as reliable, for that department requires the various systems to submit to tests before they are permitted to be used.

The advantages of concrete-floor construction are lightness and relative cheapness. The floors weigh from 40 to 60 pounds per square foot. The points to watch in concrete-floor construction are the use of inferior cement, sand, cinders, etc., and the misplacement of the reinforcements. When properly constructed, a reliable concrete-floor system makes a strong, light floor; and where cinder concrete is used should withstand any ordinary fire.

**20. Openings in Concrete Floors: Chases in Walls.** After the floors are constructed, openings are often cut for pipes, etc. This is liable to weaken the floor and should be avoided if possible by taking special care to have all necessary openings left when the floors are being built. But if these openings are necessary afterwards, they should be no larger than is absolutely necessary and should be well boxed with iron. Care should also be taken to leave chases in walls

for pipes, etc., and any bolts that may be necessary for fastening woodwork, etc. should be built into the concrete.

**21. Thickness of Concrete Cellar Floors.**—Concrete floors for areas or cellars should be not less than 5 inches in thickness, with a top coat of strong cement mortar troweled to a smooth surface. This coat should be not less than 1 inch in thickness. The under coat should be green, or if set, should be wet before the top coat is applied, and it should be kept moist while setting.

**22. Dividing Concrete Floors Into Blocks.**—Where there is no danger of water working up through the floor, it is well to lay the concrete in separate blocks with paper between the joints, so that these blocks will be entirely independent; this reduces the effects of shrinkage. Where the floor is not so divided, it is good practice to cut a deep joint subdividing the top coat only into blocks as stated. Natural and artificial cements should not be used for two adjacent coats, as they will not adhere to each other. The same cement should always be used for such coats.

**23. Drainage of Footings.**—To drain the footings, a line of porous terra-cotta pipe or agricultural tile with butted joints is placed at the base of the footings. This pipe or tile should be laid with a pitch of not less than $\frac{1}{4}$ inch to the foot, and should have the joints wrapped with asphalted burlap or felt. The trench is usually filled above the pipe, to within a foot of grade, with broken stone, brick, or similar material. Unless a large spring is to be drained, the line of pipe may safely be run to some convenient distance from the building and the water allowed to soak away into the surrounding soil by means of a stone pit. If the soil is impervious, or the amount of water is excessive, some outlet other than a stone pit should be provided.

**24. Furring for Brick and Stone Walls.**—The furring for brick or stone walls often consists of hollow bricks, which may be bonded into the wall and into which nails may be driven to fasten trim. Laths and wooden bricks are often built into brick walls to afford nailing for wooden furring on which the laths are placed. Stone walls are plugged with wood for the same purpose, but the hollow bricks, though more expensive, are to be preferred.

**25. Damp Walls.**—A damp wall cannot usually be made permanently dry by an inside surface coating. Such expedients at their very best almost always give only temporary relief. The best way to get rid of dampness in walls is to remove its cause.

**26. Damp-proof courses** are often placed in walls to prevent water from traveling down into an arch from a parapet wall or

from the footings up through a foundation wall, etc. Such courses are also used beneath a cellar floor where water is liable to force its way through. Asphalt, asphalted felt, and even sheet lead are used for this purpose.

**27. Waterproof Brick Walls.**—A good way to obtain a waterproof brick wall is to leave a $1\frac{1}{2}$- or 2-inch space in the wall and then fill this space with an asphalt cement or other similar preparation. The two parts of the wall should be well bonded to each other with copper ties.

**28. Chimney Tie-Rods.**—Tie-rods are used to anchor tall chimneys to roofs. The exposed ends of these rods are often finished with some decorative feature, such as a shield or rosette. Tie-rods and the anchors of floor joists are recognized decorative features in the Netherlands, Germany, and England.

**29. Floor-Joist Anchors and Hangers.**—Wrought- and cast-iron hangers are now made that are built into the wall and tie the joist to it by means of a lug at the bottom of the hanger, which engages into the bed of the beam. These hangers are made in many types. They should allow free circulation about the end of the joist, in order to prevent dry rot.

**30. Building Sand.**—Good sand must be sharp; that is, each grain should be angular in shape and free from clay or loam. Sea and tidal-river sand should be washed in running water before using, as the salt will crystallize on the wall, etc., if this is not done. Sea and river sand is much less sharp than bank sand and except where a clean white mortar for pointing or for plastering is desired, it should not be used. The best sand for all purposes, except the white coat in plastering, or where its color prevents its use, is finely crushed granite screenings. This sand, however, should not be too fine.

**31. Test for Building Sand.**—To test the amount of loam in sand, place a handful in a quart glass jar and then fill the jar with water. Stir this mixture well. After the sand has settled to the bottom, pour the muddied water above it into a second jar and allow this to settle for a few hours. If the sediment on the bottom of the second jar is of appreciable thickness, the sand should be rejected or else washed clear of loam before using.

**32. Lime.—Fat lime,** or lime with not more than 5 or 6 per cent. of impurities, should not be used where any moisture is encountered. It should be used for work above grade, plastering, or for whitewash. Good ordinary lime should have from 6 to 10 per cent of impurities, such as silica, alumina, etc.

**33. Hydraulic lime,** or lime containing from 5 to 20 per cent. of impurities, should be used for work below grade or in damp spots.

**34. Lime Grinding.**—Grinding the lime just before slaking is a good thing to do, as it insures a more thorough slaking and is less likely to leave unslaked lumps that are liable to cause trouble after being built into the wall, where the slaking process continues. Portable mortar mills for grinding mortar are used in England. This kind of mill is a combined engine and mill on wheels, and where used minimizes the danger of refractory lumps of lime in the mortar. Lime should be slaked separately and allowed to stand for at least 1 week before using. The resultant *lime putty* should be free from unslaked particles.

**35. Cements.**—Cements may be divided into two classes—the *natural* and the *artificial*. The natural cements are generally called *Rosendale cements*, this name being derived from the name of a well-known brand made in Ulster County, New York. The artificial cements are usually called *Portland cements*, the name being taken from a very strong natural cement made in England. Slaking does not occur with either Rosendale or Portland cements, the sand and stone being thoroughly mixed dry with the cement. When the mortar is mixed it should be used at once. Freezing temperature will not harm Portland-cement mortar, if the cement can be kept from freezing until the setting has commenced; but Rosendale cements should not be used in freezing weather. Salt added to water used for mortar will retard freezing.

**36. Plaster of Paris** is calcined gypsum. It is used for the white coat in plastering, where its great shrinkage is regulated by the addition of sand. It is also used for making what is called *composition ornament*, such as capitals, brackets, moldings, etc., and for *staff*.

**37. Mortar Mixing.**—Mortar should be mixed in special water-tight boxes, which should be kept as clean as possible. This insures the exclusion of earthy matter. Mortar should never be mixed on the ground.

**38. Waterproof Mortar.**—To make a waterproof mortar, mix about 1 per cent., by weight, of powdered alum with dry sand and cement, and thoroughly dissolve about 1 per cent. of soft soap or any potash soap in the water that is to be used for mixing. When the mortar is mixed, the alum and the potash form a compound that is insoluble in water and makes the mortar non-absorbent.

**39. Freezing Mortar.**—To retard the freezing of mortar and to add considerably to its strength, add 1 pound of the coarsest sugar or common molasses to each gallon of water intended to be used for

mixing. Not more than 2 per cent. of sugar or molasses should be added, as this weakens the mortar, and none should be used where mortar will be under water or in damp situations.

**40. Proportions for Mortars.**—Proportions for lime mortar and cement mortar vary somewhat, but good practice calls for 1 to 3 for lime mortar, 1 to 2 for Rosendale-cement mortar, and 1 to 3 for Portland-cement mortar. Ten per cent. of lime putty added to cement mortar makes it work easier, enabling the bricklayer to make a neater job. A good proportion for lime-cement mortar is 1 part of lime putty, 1 of cement, and 6 of sand. The bearing power of brickwork laid in the different mortars may be obtained from almost any reliable handbook.

**41. Staining of Limestone.**—Ordinary cement will stain limestones, marbles, and some granular sandstones, and such stone should be laid up in lime mortar or La Farge cement, with the backing of the same laid in lime mortar; or if laid in cement, the back of the facing should be painted with some damp-resisting paint that will prevent the water from the cement from working into the facing, but at the same time not destroy the adhesion of the backing.

**42. Ashlar facing** should be well bonded into rough backing, either by alternating thin and thick courses of sufficient depth or by tying each stone with a galvanized-iron anchor doweled into the facing and built into the backing.

**43. Rough Masonry.**—All rough masonry should be laid as level as possible, with the stone on its natural bed; joints should be left open for pointing on completion.

**44. Protection of Carved Work.**—Where there is danger of the finished work and carving being damaged, protection should be provided by strongly boxing the same with rough white-pine boards. Hemlock or any resinous wood should not be used, as it is liable to stain the stone.

**45. Patching Carved Work.**—Patches are sometimes placed in carving where it has been damaged. The right to promptly remove such work should be reserved to the architect in the specifications. These patches are often very difficult to detect, as the stone is usually covered with a fine dust, which hides such patches. They may be easily detected, however, by wiping the carving with a wet rag. These patches should not be allowed to remain, as they are likely, in time, either to drop out or to become noticeable.

**46. Carving** of stone is usually done from plaster or clay models that have been approved by the architect.

**47. Cleaning and Pointing Walls.**—The work of cleaning and pointing stone or brick walls is usually done at the same time. The cleaning consists in removing dirt, stains, dust, pieces of mortar, etc. by means of steel brushes, scrubbing with dilute muriatic acid, or the sand blast.

**48. Technical Names of Bricks.**—The technical names adopted by brickmakers are confusing and differ in almost every state, but the bricks in common use may be roughly classed as follows: *Pressed*, *vitrified*, *paving*, *fire*, *enameled*, and *common bricks*.

**49. Brick Colors.**—The color of common bricks depends entirely on the nature of the clay from which the bricks are made. Iron, magnesia, and other substances are used to color pressed brick and a great many shades can now be obtained.

**50. Mortar for Brickwork.**—Cement mortar should be used where the brickwork is under considerable weight or where it is below ground or for chimneys above the roof.

Lime putty and sand make the best lime mortar for brickwork.

**51. Flemish and English bond brickwork** is not popular with bricklayers, who must be watched carefully to insure headers being directly over each other.

**52. Efflorescence on Brickwork.**—Efflorescence is a very difficult blemish to prevent or to permanently remove, and the chemistry involved in the production of the salt or salts that are to blame is difficult to establish. German chemists suggest that, before burning, the bricks be immersed in dilute hydrochloric acid, the strength of the solution to be inversely proportional to the amount of lime in the clay. This is claimed to be efficaceous. Where a wall is already built and a method of keeping the efflorescence from reappearing after once being washed off is desired, painting with boiled oil or some paraffin preparation is suggested; this should render the surface of the brickwork impervious to moisture. Successive coats of alum and soap solutions are also said to be useful.

**53. Wetting Bricks.**—The practice of wetting bricks about to be laid, especially in hot weather, is necessary in order to prevent undue absorption of moisture from the mortar, as this would reduce its binding and setting properties.

**54. Laying Brickwork With Lime Mortar.**—In freezing weather, laying brickwork with lime mortar should not be allowed, if it is possible to avoid it; but if the work must be done, the mortar should be made in small quantities, with freshly slaked lime and warm water, and used at once, or treated as described in Art. **39.**

The work should be well covered with sacking and boards on leaving at night and at points where the work will be at a temporary stand-still. The piles of brick should be entirely covered with canvas also, to protect them from rain, frost, etc

**55. Absorption of Brick.**—The absorption of a brick should not be more than 10 per cent. of its weight.

**56. Mortar Joints in Brickwork.**—The mortar joints in brickwork exert considerable influence on the strength of the brickwork, and are the weakest part of the wall. Brickwork laid in lime mortar is probably about three-quarters as strong as that laid in cement mortar. Imperfectly mixed mortar or joints not well filled up lessen the strength of the brickwork. Mortar in the joint is much stronger than in cubes under a testing machine.

**57. Fireplace Throats.**—Throats for fireplaces should be carefully constructed, and should be no larger than is necessary for the passage of the products of combustion into the flue. The throat should be provided with a shutter by which to regulate the size of the opening; it should also include a shelf to catch the falling soot, which may be cleaned off from time to time. Cast-iron combination throats and dampers are made, which are properly proportioned for various sizes of openings. These have proved very satisfactory and are used in the best class of work.

**58. Smoky Fireplaces.**—A smoky fireplace is not always due to improper proportions of the fireplace itself, but often to an insufficient supply of air from the room or to down drafts of deflected air from surrounding roofs when the top of the chimney is too low. The remedies for both cases suggest themselves, the sectional area of flues is usually made one-tenth the area of the fireplace opening.

**59. Chimneys in outside walls** should have the flues protected from the chilling of the outside air and consequent stoppage of circulation, by having at least an 8-inch wall in addition to the customary terra-cotta lining.

**60. Chimney Tops of Terra Cotta.**—Terra-cotta chimney tops are manufactured in many styles, some of which are very decorative. These tops may be used to extend the height of the flues to remedy a smoking fireplace or may be used simply as a decorative feature.

**61. Smoke flues** not terminated by a fireplace should be extended to an accessible distance from the cellar floor and provided with a cast-iron clean-out frame and door similar to that used for ash-pits.

**62. Coating Brickwork.**—The coating of brickwork with boiled linseed oil is done to serve as a filler, thus preventing absorption of foreign substances, and to bring out the color.

**63. Time Required to Build a Chimney.**—The rate of building a chimney with lime mortar should not be more than 10 feet per day, as a faster rate than this would not allow mortar to set sufficiently, thus tending to squeeze out the lower joints.

**64. Molded Bricks.**—Almost every profile and ornament in the form of molded bricks are now manufactured and when properly used they give very satisfactory results. Bricks should be examined to see that they are true and that their beds are not too smooth, as this gives no clinch for the mortar.

**65. Lime-and-Sand Bricks.**—A brick composed of finely ground sand and lime is now being manufactured. This brick makes a very good appearance, but its durability so far is an open question, which time only can settle definitely.

**66. Pressed Bricks.**—The interior walls of churches and other public buildings are now frequently lined with pressed bricks, which take the place of a plaster wall at little additional cost. This lining of pressed bricks makes a much more durable and lasting surface.

**67. Enameled bricks** are made in many varieties and are suitable for such uses as bathrooms, swimming pools, kitchens, light wells, etc. They should be laid in Keene's cement colored to match the enamel.

**68. Brick Mantels.**—Brick mantels are used in the best work, and bricks especially for this purpose are manufactured by some concerns. Ordinary pressed bricks, and even common bricks, however, in the care of a good designer, are capable of receiving very satisfactory treatment for this purpose.

**69. Marble Mosaic Floors.**—If possible, mosaic floors should be used for bathrooms, vestibules, and corridors of public buildings, as they are cheaper than wood in the end. The base used with these floors and plinth blocks of doorway trim should be of marble, so that the floors may be washed without the water coming in contact with the woodwork. **Terrazza** is a marble mosaic floor made of irregular-shaped small pieces of marble of different colors embedded in cement. Both of these floors should be laid in Portland cement.

**70. Finishing Mosaic Floors.**—A good way to finish a mosaic floor is to soak it well with raw linseed oil, well rubbed in.

This should bring out the color, after which it may be finished with a coating of wax.

**71. Scaglióla, or Imitation Marble.**—Artificial marble is now made of Keene's cement and coloring matter. It should not be used for floors, but if well made is acceptable for wainscoting, columns, cornices, etc. for inside decoration. Wainscot bases and plinths should be made of natural marble, as this will better withstand the contact of a mop, water, etc. A white opalescent glass is now made, which as a substitute for marble is used for wainscoting, floor slabs, urinal stalls, etc.

**72. Advantages of Artificial Marble.**—The advantages of artificial marble are its cheapness, freedom from cracks and flaws, and the fact that it can be made in sizes and shapes that would be almost impossible or very expensive in real marble.

**73. Method of Fastening Marble Slabs.**—To fasten marble slabs in place, copper or brass cramps, screws, or wire should be used. Exposed screws should be plated to match other hardware.

**74. Marble fireplace facings** undergo slight expansion under moderate heat, and this must be taken into account in the jointing. Marble slabs expand about $\frac{1}{30}$ inch for every foot of their length at 230° F.

**75. Polishing Marble.**—Alum for polishing marble is objectionable and its use should not be allowed, as it fills the pores and makes the marble very susceptible to stain. Slabs can be tested for this by simply wetting them; this treatment will leave whitish spots when the water has dried.

**76. Marble Cement.**—A cement for marble can be made by soaking plaster of Paris in a saturated solution of alum, after which it is baked in an oven and then ground to a powder. This cement may be colored and, when in place, polished to imitate the marble with which it is to be used. This is practically a Keene cement. Colored gum lac is also used.

**77. Bricks for Pavements.**—Bricks on edge for pavements in stables, court yards, etc. are preferable to stone, and should be laid in cement mortar and well grouted with neat cement.

**78. Asphalt Flooring.**—Flooring made of asphalt is impervious to water and is therefore a most sanitary pavement that is very suitable for stables, etc. It may be from $\frac{1}{2}$ inch to $1\frac{1}{4}$ inches thick, depending on its use. The surface of the concrete foundation on which the asphalt is laid should be perfectly dry and free from dust when the asphalt is placed.

**79. Gutta-percha, or rubber, pavement** is sometimes laid in hospitals, where quiet is essential, but its cost prohibits general use. It should be laid on a concrete base.

**80. Tar Pavements.**—Tar paving for courts, playgrounds, etc. should be used only on flat surfaces. This kind of paving is soft and agreeable to the tread, and is composed of heated gravel or broken stone about $\frac{3}{8}$ inch in diameter mixed with boiling tar or a mixture of tar and asphalt. Where there is much traffic, two coats should be laid on a bed of concrete, the under coat being about $1\frac{1}{2}$ inches and the top coat about $\frac{3}{4}$ inch in thickness.

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### PLASTERING

**81. Lime for Interior Plastering.**—A rich lime should be used for interior plastering, and should not have more than 6 per cent. of impurities. This lime is unfit for use where much strength is required and for exterior plastering where exposed to the weather.

**82. Lime for White Coat.**—To insure perfect slaking for the white coat, the lime should stand a couple of weeks or more after slaking and until the superfluous water has evaporated. The resultant *lime putty* is reasonably certain to have no small unslaked lumps, thus avoiding blisters in the finished coat. Grinding the lime, as mentioned before, is also good practice in this connection.

**83. Necessity of Preparing Sufficient Lime Putty.** If possible, sufficient lime putty should be prepared to do all the plastering required in the building. Sometimes, for various reasons, the contractor will not make enough lime putty for the whole building, and if the upper stories are plastered first, the supply may be exhausted long before the lower and more important stories are reached. In this event, some fresh lime putty will have to be mixed, and the contractor, being generally urged to hurry the work along, may be tempted to use this new mixture of putty before it is thoroughly seasoned, with the evil results just mentioned.

**84. Use of Sand in Plaster.**—The use of sand in plaster is for the two-fold purpose of regulating and preventing excessive shrinkage and to supply centers of crystallization. The fact that sand is cheaper than lime is sometimes a temptation for the contractor to put in too much sand. The usual proportion for good plaster—brown or scratch coat—is one part of lime to two parts of sand.

Sea and tidal-river sands should be avoided, as they contain a certain amount of salt, which is sure to discolor the walls and tends to keep them damp. All sand used for plastering in good work should be washed.

**85. Artificial Plasters.**—Keene's, Windsor, and Adamant are the better-known artificial plasters used in the United States. They all give good hard surfaces that can be polished and also take paint well. These plasters are made mixed with fiber and sand for the different coats and should be applied according to directions.

**86. Lathing.**—Wooden laths used in plastering should be free from sap, knots, cross-grain, crookedness, and undue smoothness. The sap decays and stains the plaster, the smoothness does not allow sufficient grip for the plaster, and crookedness prevents a uniform distance between the laths. The thicker laths, if there are any, should be used on the ceiling, as more strength is required there than on the side walls. All wooden laths delivered at a building should be protected from rain or snow.

**87. Metal lathing** is used extensively on metal studding and also on wooden studding over heat flues, behind tiling, or where greater strength is required than the wooden laths afford. There are many kinds in use, but the better makes do not differ greatly in efficiency. Where Keene's cement is used, the nails should be of galvanized iron or of copper.

**88. Lathing Nails.**—The nails used for lathing are generally of iron—cut or wrought—and should not be smaller in size than fourpenny nails. Threepenny nails are sometimes used, but are too small for good work. Copper or zinc nails are quite expensive, but make a much better job, as they will neither rust nor discolor the plaster.

**89. Plaster Thickness.**—The thickness of plaster on wooden lath should not be less than $\frac{5}{8}$ nor more than $\frac{3}{4}$ inch, including the laths. Greater thickness than this only imposes extra weight on the lath without corresponding benefit, and thinner plaster is liable to cause cracks, due to too little strength to resist the inevitable shrinkage of the laths.

**90. The Scratch Coat.**—The first, or scratch, coat in ordinary plaster is composed of lime and sand in the proportion of one to two, with ox or goat hair mixed in, about $1\frac{3}{4}$ pounds to each bushel of lime.

**91. The Brown Coat.**—The second, or brown, coat has a little more sand than the first coat, and about $\frac{1}{2}$ pound of hair to each bushel of lime.

**92. The Finished Coat.**—The third, or finished, coat is usually a *sand finish* or a *white coat*. The sand finish is composed of lime putty and washed white sand. The white coat is *fine stuff*, or screened lime putty mixed with a small amount of plaster of Paris or marble dust or both. Too much plaster of Paris will cause surface

cracks. Lime putty containing plaster of Paris is called *gauged stuff*. Four parts of plaster of Paris and one part of sand or marble dust to twenty-four parts is the usual proportion for the white coat. For the sand finish, sand takes the place of marble dust and plaster of Paris in the white coat.

**93. Causes of Plaster Cracks.**—Cracks in plaster are caused by shrinkage in the framework of the building; too little sand; the use of inferior materials; laying plaster on walls that are too dry; laying one coat on another before the under coat is properly set; and the mixing of too much plaster of Paris in gauged mortar.

**94. Effects of Plaster Freezing.**—If ordinary plaster becomes frozen, its usefulness is destroyed; some patent-plaster walls, if not frozen until 36 hours after being put up, are not harmed.

**95. Plastering on Brick or Stone Walls.**—Plaster placed directly on brick or stone walls will not obtain a strong bond with the wall unless the stone wall is rough or the joints in the brickwork are scraped out. If these walls have been wet during the construction of the building, they should be well dried out before the plastering is applied, although the surface should be dampened enough to prevent excessive absorption of water from the plaster, which will usually cause cracks, as mentioned in Art. **93.**

Plaster placed directly on the brickwork of walls impossible to make hollow may be prevented from being stained by dampness due to rain storms, etc. by painting the surface of the wall with R. I. W. waterproof paint or some similar paint on which the plaster can be placed, but which will keep out the moisture. This paint should be put on carefully so as to cover all points of the wall surface. There is, however, some possibility of this paint hardening with age and finally decomposing enough to allow the passage of water. Nevertheless, in walls of this kind, it is the best method of keeping out the moisture, except, possibly, the oiling of the outer surface or coating with alum and soap solutions, which must be renewed every few years.

**96. Back Plastering of Ceilings.**—To prevent joist lines, which are due to the settlement of dust into the plaster from above, from showing in the ceilings, "back plaster" between the joists at a few inches above the ceiling, nailing the laths to cleats attached to the side of the joists.

**97. Plaster Stains.**—The staining of the plaster on wooden laths is usually due to sappy knots, or sometimes to foreign matter that has found its way into the plaster because of an unclean mortar box. A separate mixing box should be used for the white coat.

On brick, terra cotta, or stone, it is harder to locate the causes, but the use of the R. I. W. paint or a similar coating will usually prevent

such stains. The uncertainty as to the life of the coating is not so important here as where the passage of water is to be prevented, for the plaster will be past the danger of staining from these sources after a few weeks are past.

**98. Exterior Plaster.**—The best exterior plaster for half-timber work, etc. is made of Portland cement and sand. The lighter Portland is perhaps the best, as it sets more rapidly.

**99. Rough cast,** or **pebble dash,** generally consists of two coats of the plaster just mentioned, or lime plaster with hair in the first coat, on which pebbles or other small material are dashed while the second coat is still moist. The pebbles may also be pressed in place one at a time. This work is used for half-timber work and other exterior plaster surfaces.

**100. Composition** and **staff** are both made from plaster of Paris and hemp or other fiber, the difference being only in the amount of fiber. The amount of fiber used in staff is much more than that in composition, which is employed only for comparatively small pieces of ornament, especially interior work. This material will not withstand a climate where there are sudden changes of temperature or where the temperatures are extreme, and the safest method, if used at all, is to confine it to interiors, but even here its brittleness is a great objection.

Very good column caps, panels, molding ornaments, etc. are now made of this material, and where the work is not to be from special designs, the stock designs may be specified by catalog number.

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## TERRA-COTTA, FAIENCE, AND SLATE WORK

**101. Disadvantages of Using Terra Cotta.**—The chief disadvantage in using terra cotta is the difficulty of avoiding shrinkage, which causes uneven lines in cornices, etc. The delivery of terra cotta is usually very uncertain, and for this reason it is well to place orders for the same as early as possible.

**102. Drawings for Terra-Cotta Work.**—The detail drawings for terra cotta are usually made from the architect's small scale elevations and sections by the manufacturer's draftsmen, who make due allowance for shrinkage. Each block has a certain mark put on it that agrees with that on the setting drawings, which enables the foreman to locate it readily on the work. This practice is common with cut stonework also.

**103. Qualities of Terra Cotta.**—The ideal terra-cotta clay contains about 70 per cent. of silica and 30 per cent. of alumina

The percentage of absorption of terra cotta should not be more than 10 or 12 per cent., or acids in the atmosphere and the action of frost will have a deleterious effect on it. Therefore, the more dense terra cotta is the better it will be for ornamental work.

A well-burned piece of terra cotta that is perfectly sound will ring clear when struck.

**104. Terra-Cotta Models.**—Models for ornamental terra cotta should be submitted to and approved by the architect. These models are usually made to a scale of 13 inches to the foot, in order to make proper allowance for shrinkage.

**105. Cement for Terra Cotta.**—Ornamental terra cotta should be set in Portland or Rosendale cement, well anchored to backing wherever necessary.

**106. Shrinkage of Terra Cotta.**—The shrinkage of terra cotta compels the making of sills, cornices, etc. in pieces short enough to reduce any irregularities to a minimum. Such pieces where exposed to the weather should be lapped at upper-surface joints.

**107. Chiseling of Terra Cotta.**—Chiseling the face of terra cotta to get a better joint, etc. should not be allowed, as this will expose the more porous material under the vitrified surface to the action of the atmosphere and look bad besides.

**108. Terra Cotta for Heavy Loads.**—Structural terra cotta, being hollow, should be filled with cinder concrete where it is required to carry any great weight. Where this is done, care should be taken to wet the terra cotta before filling.

**109. Terra-Cotta Arches.**—The different types of terra-cotta arches for floor construction are either of porous or of dense terra cotta. The dense terra cotta is the stronger, and is used for arches. The porous terra cotta is to be preferred for partitions and is used for grounds to which the trim, etc. may be nailed directly. The porous terra cotta offers more resistance to fire than the dense.

**110. Methods of Building Arches.**—Terra-cotta floor arches are built in two ways, by the *end method* and by the *side method*. The end method is much the stronger if properly built. Care should be taken in this method to see that webs match exactly and that the joints are well filled with Portland-cement mortar and the skewbacks well bedded in the same.

**111. Depth of Arches.**—The depth of terra-cotta floor arches varies from 6 to 15 inches, according to the span and the load that is to be carried. The New York Building Laws require $1\frac{3}{4}$ inches in depth

for every foot of span, not including any terra cotta below the bottom of the beam.

**112. Pointing.**—The pointing of ornamental terra cotta should be done with Portland cement stained to match the color of the terra cotta.

**113. Protecting Terra-Cotta Work.**—The protection of ornamental terra cotta before and after setting is an important matter, and should be strictly enforced, as it is very difficult to replace broken pieces except after considerable delay and trouble, and is often impossible to remove broken pieces from their places in the building without damage to the other construction.

**114. Partition terra-cotta blocks** are made 2, 3, 4, and 6 inches thick. Porous and semiporous tile are used for partitions, and door and other openings should be arched. These partitions are often reinforced with metal rods or with horizontal trussed wire built in the joints. Three-inch blocks are suitable for ordinary partitions, which should not be higher than 12 feet. Four-inch blocks are suitable for corridor partitions, which should not be higher than 14 feet. Six-inch partitions should not be higher than 20 feet. These blocks are set with their axes vertical.

**115. Book Tile.**—Roof or ceiling blocks, also called *book tile*, are 2 and 3 inches thick and are used on pitched roofs. They are usually covered with concrete, or if the roof is not too steep, with asphalt, and are supported on steel T's.

**116. Roofing tile** should be laid in bituminous mastic or some similar mastic cement, and should be fastened in place with zinc or copper nails or with copper wire. The roof should be sheathed under the tiling and covered with a good sheathing paper, unless the tile is very tight fitting, so that there is no danger of drafts under them, in which case they may be laid on shingle lath.

**117. Types of Roofing Tile.**—There are a number of types of roofing tile on the market. They are generally made in reds, but are enameled in greens and other colors as desired. The effect of a single tile gives little idea as to how the finished roof will appear, so it is well to see the tiles laid in masses on roofs before deciding on the type to use. In figuring the weight of tile for a roof, 10 per cent. should be added for the weight of absorbed moisture.

**118. Slate Testing.**—To test a slate, place on edge in water; if after 12 hours the water of absorption reaches the top, the slate should be rejected. If it rises about $\frac{1}{8}$ to $\frac{1}{2}$ inch, it may be considered good. Good slate is not greasy to the touch.

**119. Uses of Slate.**—Slate hips and ridges fastened with brass or copper screws are used in England. They are laid in slater's cement.

Slate is also used for urinal partitions and backs, shelving, cisterns, bases, etc. Red, green, and gray slates are obtainable in different shades.

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## CARPENTER WORK

**120. Uses of Timber.**—The various kinds of timber are generally used for the following purposes:

**Framing:** hemlock, spruce, Georgia pine, oak, redwood, cypress.

**Sheathing:** hemlock, yellow pine, white pine, redwood.

**Shingles:** cedar, redwood, cypress, white pine.

**Siding and Other Outside Trim:** white pine, cypress, whitewood, redwood.

**Interior Finish:** oak, white pine, yellow pine, maple, birch, cherry, mahogany, chestnut, whitewood, teak, jarrah, etc.

**Piles and in Wet Situations:** elm, beech, oak, Georgia pine, teak, jarrah, locust.

**Fence Posts, Etc.:** chestnut.

**Half Timber:** yellow pine, cypress, white pine.

**121. Growth and Cutting.**—Ordinarily, the architect is not concerned with the growth of timber, but should be with the condition of timber as delivered at the building. Therefore, a knowledge of the methods of cutting and seasoning is necessary, so that a better conclusion as to the quality of timber delivered for inspection may be reached.

**122. English Terms.**—*Balk*, *batten*, and *deal* are terms used in England to signify a timber of considerable cross-section, a stick about 1 in. × 3 in., and a plank, respectively.

**123. Specifying Timber.**—It will be necessary in writing specifications to give the names of the particular kinds of timber to be used for different purposes on the work, and to state the qualities that will be demanded in same.

**124. Bled Timber.**—The Southern Lumber Manufacturers' Association claims, and backs up with tests, that bled Georgia long-leaved pine is just as strong as that which has not been bled. Other authorities hold that bled timber is brittle and liable to dry rot.

**125. Forest-Grown Timber.**—Forest timber is better than that grown in open spaces, and timber grown in dry ground is better than that grown in wet ground.

**126. Dry Rot.**—The disease of timber known as *dry rot* is difficult to eradicate, but is prevented by sunlight and circulation of air. For this reason, framing timbers should always have their ends free, as is provided by the use of standard hangers. To eradicate dry rot, cut away and burn off all affected parts and coat all sound timber left with boiling tar or a cold solution of corrosive sublimate, and also provide for a good circulation of air about the timber.

**127. Wet Rot.**—Wet rot is avoided by keeping timber dry or else continually wet. If neither of these conditions can be had, impregnate the wood thoroughly with creosote, which will also keep the Teredo (a wood worm) from attacking the wood when placed in salt water.

**128. Timber Pine.**—Cuban southern pine is the hardest and strongest of the southern pines and contains the most pitch. Long-leaved pine stands next in strength, loblolly next, and short-leaved pine last. Yard-dried yellow pine is about 50 per cent. stronger than green timber, and kiln-dried about 30 per cent. stronger than yard-dried.

**129. Air and Water Seasoning.**—To **air-season** timber requires anywhere from 2 to 4 years. **Water seasoning,** which is simply a method of dissolving the sap from the wood by soaking in running water for about 2 weeks, instead of getting rid of the sap by evaporation, as by the other methods, demands air or kiln drying afterwards to free it from moisture and remaining sap.

**130. Air- and Kiln-Dried Trim.**—Interior and exterior trim should be both air- and kiln-dried, and when possible should be stacked in the building for some time before being put in place, in order that it may adapt itself to the atmosphere of the building.

**131. Shrinkage.**—The shrinkage of timber is greatest transversely to the grain, and this should be avoided or equalized throughout the framing of a building as much as possible. It is the principal cause of cracks in plaster, binding doors and windows, and other things of a similar nature.

**132. Grounds** for trim, wainscot, etc. should have beveled edges to form a key for plaster; and where joists or studding are more than 2 inches thick and it is possible to do so, $1'' \times 2''$ cleats should be nailed on them to receive the lath, as the greater width of the joists and studding cuts off considerable of the keys of plaster in the length of a lath.

**133. Floor joists** and **tie-beams** should be crowned slightly at the center to allow for the sagging when the weight of the floor, etc. is placed on them.

**134. Floor Bridging.**—The bridging for floors should be fastened in place as soon as the floorbeams are leveled, for if the flooring is fastened first, as is often done, the initial strain comes on the flooring and any irregularities in it are made permanent by the nailing of the bridging.

**135. Utility of Partition Bridging.**—Bridging between the studding makes good fire-stops and stiffens the partitions. This bridging should be placed at an angle of 45°, the adjacent ends of bridging being on the same level. This makes a stiffer job and gives a better chance for the plaster key than horizontal bridging.

**136. Studding and Joists.**—The lengths of studding and joists should conform as nearly as possible to the stock lengths of timber. This means a considerable saving in a large building, as there is less cutting to do and less waste of material.

The cutting of joists to fit over the wall plate is customary, but it is better to rest the joist directly upon the plate, as this gives the strength of the full depth of the beam. The objection to this is that it requires a greater length of studding for the same height of story and consequently adds to the cost of the building. The space between the joists from wall to under side of floor is often filled with brick to form a fire-stop. The brick should be kept not less than 1 inch below floor to allow for shrinkage of joists.

Studding and joists are spaced 12 or 16 inches on centers in order to obtain even nailing for lath that are 4 feet long. This point should be kept in mind in making framing plans.

**137. Floorbeams** should be butted, not lapped, and cleats should be nailed to each side lapping both beams and thus tying them together.

**138. Whitewash as Fireproofing.**—A whitewash coating on the entire framework of a building is an inexpensive method of adding considerably to its fire-retarding qualities. A fireproof paint could also be used, but would be more expensive.

**139. Chimney Angles.**—Where chimneys are reduced in width at any floor, the flues are often too close for safety to the trimmer joists, at the angle where the chimney is reduced in size, and the flue is on a pitch. This should be watched, and avoided by throwing the flue over at a lower level or keeping the joists well away from the angle.

**140. Hearth Arches.**—Where hearth arches are employed to support large fireplace hearths, iron rods may be built into the chimney and allowed to pierce the header against which the arch

abuts, being fitted on the opposite side with bolts and washers. This will prevent the header from giving any, by reason of the thrust of the arch.

**141. Hips.**—Hips at an angle of 45° on the plan are the only ones suitable for a *Boston hip*, as unequal angles make unequal widths for the shingles on opposite sides of the hip. Where roofs on either side of the hip have unequal pitches, the shingles would have different widths to the weather on the two pitches if desired that the butt lines of the hip shingles should coincide with those of the roof. This does not look well, however, and is very seldom done.

**142. Window Framing.**—When framing for windows, the carpenter adds from 10 to 12 inches to the width of the glass to get the rough framed opening if it is double hung, and 8 to 10 inches if a casement. The size of glass is given on the elevations, and the carpenter makes calculations from these dimensions, adding to them the specified widths of the sash, muntins, pulley stiles, boxes, and back casings, if any. The additional height is figured in the same way, and is from 10 to 12 inches.

**143. Door sizes** to the finished jamb are given on drawings, and in framing a total allowance of about 5 inches in width and about 3 inches in height is made for false jambs and head. The carpenter should block well behind the false jambs, especially opposite the hinges. This is very important in connection with double-acting doors. The allowances spoken of here and in Art. **142** are obtained from the full-size details.

**144. Plaster grounds** for trim, wainscot, etc. should be about $\frac{1}{4}$ inch narrower than the trim that is to be nailed to it, in order that the finished work may not have too much lap on the plaster.

**145. Stock Sizes of Lumber.**—The following is a list of the different kinds of lumber and the sizes commonly kept in stock by lumber dealers. Other woods, in thicknesses and lengths appropriate to their size of growth, may be obtained by special order. This list is given only as a guide and may include more or less than will be found in some localities.

**Hemlock Framing Lumber:** $2'' \times 3''$, $2'' \times 4''$, $2'' \times 6''$, $2'' \times 8''$, $2'' \times 10''$, $2'' \times 12''$, $3'' \times 4''$, $3'' \times 6''$, $3'' \times 8''$, $3'' \times 10''$, $3'' \times 12''$, $4'' \times 4''$, $4'' \times 6''$, $4'' \times 8''$, $6'' \times 6''$, $6'' \times 8''$, $8'' \times 8''$. This timber may be obtained in even lengths of from 12 to 28 feet.

**Yellow-Pine Framing Lumber:** $2'' \times 10''$, $2'' \times 12''$, $3'' \times 10''$, $3'' \times 12''$, $4'' \times 6''$, $4'' \times 8''$, $4'' \times 10''$, $4'' \times 12''$, $6'' \times 6''$, $6'' \times 8''$, $6'' \times 10''$, $6'' \times 12''$, $8'' \times 8''$, $8'' \times 12''$, $10'' \times 10''$, $10'' \times 12''$. In even lengths of from 12 to 28 feet.

**Oak Framing Lumber:** $2'' \times 6''$, $2'' \times 8''$, $2'' \times 10''$, $2'' \times 12''$. In lengths of 16 feet.

**Matched Yellow-Pine Flooring:** $\frac{5}{4}'' \times 2\frac{1}{2}''$, $\frac{4}{4}'' \times 2\frac{1}{2}''$, and also in $4\frac{1}{2}'' \times \frac{4}{4}''$; the widths given are for face and do not include tongue.

**Matched-Oak Flooring:** generally run to order.

**Matched-Maple Flooring:** $\frac{13}{16}'' \times 2\frac{1}{4}''$.

**Matched White-Pine Flooring:** $\frac{7}{8}''$ and $1\frac{1}{8}''$, $3\frac{1}{2}''$ and $2\frac{1}{2}'' \times \frac{13}{16}''$.

**Matched Yellow-Pine Ceiling:** $\frac{13}{16}'' \times 2\frac{1}{2}''$ and $3\frac{1}{4}''$.

**Matched Oregon Fir Flooring:** $2\frac{1}{2}'' \times \frac{7}{8}''$ and $2\frac{1}{2}'' \times 1\frac{1}{8}''$.

**Matched Rough Hemlock Flooring:** $\frac{7}{8}'' \times 5\frac{1}{2}''$.

**Matched Spruce Flooring:** $\frac{7}{8}'' \times 3\frac{1}{2}''$.

**Finishing Lumber:** *Oak quartered:* $\frac{5}{4}'' \times 6''$, $\frac{4}{4}'' \times 6''$, $\frac{3}{4}'' \times 6''$.

*Plain oak:* $\frac{5}{4}''$ and $\frac{4}{4}''$; same widths as oak quartered.

*Cypress:* $\frac{4}{4}''$, $\frac{5}{4}''$, $\frac{6}{4}''$, $\frac{8}{4}''$, and $\frac{12}{4}''$; widths same as oak quartered.

*Yellow poplar:* $\frac{1}{2}''$, $1''$, $1\frac{1}{4}''$, $1\frac{1}{2}''$, $2''$, $2\frac{1}{2}''$, $3''$, and $4''$; from 8 to 18 inches wide.

*Yellow pine:* $\frac{4}{4}'' \times 4''$ to $8''$, $\frac{4}{4}'' \times 10''$, $12''$, and $13''$; the same widths in $\frac{5}{4}''$ stuff, also $2'' \times 8''$ and $3'' \times 8''$.

*White pine, selected stuff:* $\frac{4}{4}''$, $\frac{5}{4}''$, $\frac{6}{4}''$, and $\frac{8}{4}'' \times 8''$.

*White pine, common:* $\frac{1}{2}'' \times 10''$, $\frac{4}{4}''$, $\frac{5}{4}''$, $\frac{6}{4}''$, $\frac{8}{4}'' \times 8''$.

*White pine, shelving:* $\frac{4}{4}'' \times 6''$, $8''$, $10''$, and $12''$; $\frac{5}{4}'' \times 6''$, $8''$, $10''$, and $12''$.

The lengths of the foregoing material are from 10 to 20 feet and the maximum width is 18 inches.

**Mahogany** is almost invariably used as a veneer, and as it is cut from the circumference of the log, it may be obtained in almost any width that can be handled and up to any practical length for working.

**White-Pine Siding:** $4''$, $5''$, and $6''$ wide; about $\frac{1}{2}''$ at butt and $\frac{1}{4}''$ at upper edge. Lengths, 10 to 16 feet.

**Shingles:** *Redwood:* $16''$ and $18''$ long.

*White pine:* $16''$ and $18''$ long.

*Red cedar:* $16''$ and $18''$ long.

*Cypress:* $16''$, $18''$, $24''$, and $26''$ long.

Widths vary from $4''$ to $8''$.

**146. Lumber Defects.**—The various defects of lumber are knots, knot holes, splits, shake, wane, red heart, pith, rot, rotten streaks, worm-holes, pitch streaks, pitch pockets, torn grain, loosened grain, seasoning or kiln checks, and sap stains. Although the architect may specify according to the grading rules adopted by the manufacturers and dealers, it might be better to state specifically and exactly what defects, if any, will be allowed, and leave the grading to the contractors, as the methods of designating the different grades are rather complicated and frequent changes are made in them; they also differ

somewhat in different localities. The common terms of classification may be obtained from almost any millman or lumber dealer.

**147. Effects of Exposure.**—Exposure to air and moisture, which is prevented by varnishes and paints, has the following effects on different kinds of woods:

Mahogany, Baltic fir, Norway fir, white pine, and chestnut become darker on exposure.

Oak, baywood, and walnut are bleached by sunlight.

Elm, teak, and greenheart are hardened by immersion in water.

Oak and firs are softened by immersion in water.

Pines and mahogany are rapidly destroyed by immersion in water.

Oak, spruce, chestnut, and larch become hard on exposure to the air.

Baltic fir, baywood, redwood, and certain species of mahogany become brittle on exposure to air.

**148. Shingles.**—Shingles wider than 7 inches should not be allowed, as they are apt to curl. Shingles should have two nails apiece and should not be laid more than 5 inches to the weather.

**149. Pitches for Different Roofing Materials.**—The proper pitches for different roofing materials is shown graphically

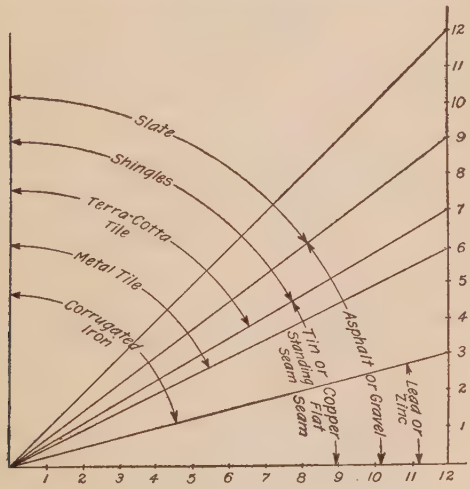


FIG. 2

in Fig. 2. Asphalt roofing is frequently laid to the pitches shown, but it would be safer to confine it under *6* to *12*, as indicated in the figure.

The lower the pitch of a roof, the greater will be the thrust. *King-post* and *queen-post trusses* are used for spans under 45 feet.

**150. Snow Gratings.**—In England, snow gratings are used for large box gutters to prevent them from clogging with snow. These gratings are usually made of $2'' \times \frac{7}{8}''$ cleats nailed about $\frac{1}{2}$ inch apart to bearing pieces adjusted to the gutter width and cut out at the bottom to allow the flow of water in the gutter. The length of the sections should not be more than 6 feet, in order that they may be easily handled.

**151. Pitched Roofs.**—Pitched roofs under 45° should be shingled very carefully, and shingles should have four laps if possible. The joints should be broken in the center of the under shingle.

**152. Boxed Gutters.**—When a boxed gutter is used, it should be as large as possible, with a good clear drop from the butts of the shingles. A hanging gutter is the best gutter to use where it is possible to do so. Box parapet gutters demand great care in designing.

**153. Gambrel-Roof Valleys.**—The valleys of gambrel roofs should be wide, especially on the low pitch, and the edge shingles should be raised on a cleat to prevent water from working back under the shingles by capillary attraction. The sudden change in pitches at the hip is liable to shoot the water under the shingles.

**154. Sheathing.**—The sheathing should be put on diagonally, as it stiffens the entire building considerably and much more so than horizontal sheathing.

**155. Interior Floors.**—Oak and yellow pine are used principally for interior floors. Where carpets are not to be used, the yellow pine should be planed, scraped, and varnished. Oak or parquetry floors should always be placed on rough flooring laid diagonally. Where floors form a butt joint at door openings, etc., the joints should be strengthened with metal splines.

**156. Porch Floors.**—Fir, white pine, and cypress are used for porch floors and the like. The grooves should be generously painted with white lead and the tongues well driven into place. Straight-grained lumber is best for outside floors, and all flooring should be thoroughly seasoned.

The flooring of porches should run outwards from the building or in the direction of the pitch; the ceiling should also run in the same direction. The pitch of the floor should be about $\frac{1}{8}$ inch to the foot. No end wood should be allowed, as it is very absorbent and usually rough.

The butt joints at angles of porches should be joined by a metal spline. Heavy strap iron is frequently used.

**157. Porch Pedestals.**—Where pedestals are placed on either side of porch steps, they should be of brick or stone if permissible. If made of wood, they should be supported on masonry foundations and the wood kept as far from the ground as possible.

**158. Porch Steps.**—Wooden steps for porches, etc. should have treads formed of cleats with $\frac{3}{8}$- or $\frac{1}{4}$-inch spaces between them, for drainage; or if made of one piece, each step should have a suitable number of $\frac{1}{2}$-inch holes bored for the same purpose as the cleats.

**159. Parquetry** is a mosaic of woodwork used for floors, and is composed of small pieces tongued and grooved or splined together. Usually, the parquetry is $\frac{5}{8}$ or $\frac{7}{8}$ inch in thickness or simply a veneer glued to canvas. It is shipped by the manufacturer in small sections, which are placed together by the carpenter.

**160. Porch Posts.**—Plain porch posts are often set on iron shoes that raise the base a couple of inches from the floor, thus protecting it from moisture. All porch columns, posts, etc. should have their end wood thoroughly soaked with white lead.

**161. Screening for Porch Panels.**—A good screening for panels under porches is made of punched-steel plate thoroughly painted and screwed to rabbeted frames.

**162. Self-curved timber** makes the best work where it is possible to obtain it, and is of course more permanent and durable than a timber curved by kerfing, keying, or steaming.

**163. Space for Door Mats.**—A mat space sunk in the vestibule floor is often used in city residences. It keeps the door mat in its proper position and should be deep enough to bring the surface of the mat on a level with the floor.

**164. Gate and clothes-line posts** should have bases formed of two pieces of timber at right angles to the post with braces from post to base. All this work below ground should be thoroughly tarred or creosoted.

**165. Built-up columns** are made exclusively by several manufacturers, and as their facilities are much better for this work than those of the average mill, their product should be used where possible. Built-up columns should be primed before leaving the mill.

**166. Treads in Stairways.**—The maximum number of treads in any flight of stairs should be twelve, where possible, and the minimum, three.

**167. Winders.**—Winders should not be used if it is possible to avoid them; but if they are used, there should be an odd number in order that an angle that will be difficult to clean may not be formed in the corner.

**168. Hand Rails.**—The height of hand rails should be from 2 feet 7 inches to 2 feet 9 inches from the top of the tread, measured on a line with the face of the riser. At platforms, the rail should be 1 or 2 inches higher.

**169. Risers and Treads.**—The riser and tread of a stairway should always bear a certain relation to each other, and a good rule is to have the product equal 66. These dimensions do not include the nosing of the tread. Where the riser is $7\frac{1}{2}$ inches high, not less than 13 are required for headroom.

**170. Measurements for the Joiner.**—The joiner should take his measurements for finished inside work at the building and not from the architect's drawings, and a note stating this requirement should be made in the specifications or on the drawings.

**171. Timber Shrinkage.**—The shrinkage of timber is an important factor in building construction and should be considered in the framing of a building. The amount of shrinkage in 12 inches of transverse wood that occurs in seasoning is about as follows:

| Name of Wood | Shrinkage Inch |
|---|---|
| Cedar and cypress | .60 |
| Hemlock | .40 |
| Elm | .30 |
| Oak | .25 |
| Pine, white | .20 |
| Pine, yellow | .10 |
| Pine, yellow, long-leaved | .05 |
| Redwood, California | .05 |
| Spruce | .15 |

Even when thoroughly seasoned there is liable to be shrinkage in finishing lumber, and this should be provided for in paneling, framing, etc.

**172. Wood Characteristics.**—Woods with different characteristics are as follows:

**Elasticity:** Ash, hickory, lancewood, chestnut, yew, and snakewood.

**Elasticity and Toughness:** Oak, beech, elm, lignum vitæ, walnut, and hornbeam.

**Durability, When Kept Dry:** Cedar, oak, poplar, yellow pine, and chestnut.

**Durability, When Kept Wet:** Elm, alder, beech, plane tree, white cedar, greenheart, and teak.

**Suitable for Carving:** Pear wood, white pine, mahogany, box, lime tree, and poplar.

**173. Painting.**—All inside trim, the under side of stairways, seats, trim, etc. should be painted before being put in place, to protect against dampness, dry rot, etc.

**174. Wainscot Paneling and Casings.**—The laying out of wainscot paneling should not be left to the carpenter, but each side of the room should be laid out by the architect.

Casing plinth blocks are used to stop moldings of casings above the floor level where they are less liable to be broken or chipped.

Mitered casings if small should be tongued and grooved; larger ones should be splined.

**175. Door and Window Frames.**—The false door frames for outside doors on stone sills should have iron dowels connecting the stone sill and the frame. Door and window frames in brick or stone walls should be substantially anchored to walls by bolts built in. In the case of an outside door frame, the finished frame is nailed to the false frame and the brick molding covers the joint, the false frame being anchored to the wall.

**176. Double Floors.**—Where double floors are used, the baseboard should run to the rough floor and the finished floor should butt against this baseboard; this allows for shrinkage of the base and prevents an open joint at the floor due thereto.

**177. Single Floors.**—Where single floors with carpets are used, the shoe, or lower member of the base, should be kept $\frac{3}{16}$ inch off the floor in order to allow carpet to slip under. Where floors are to be varnished and no carpets used, the base should be well seasoned and, if possible, a grooved border with base tongued into it run about the room. If this cannot be done, the base should fit the floor as snugly as possible.

**178. Wainscoting.**—Where wainscoting butts against the back band of a door or window casing, it should be tongued into it. This allows the wainscoting to shrink away from the trim slightly without opening the joint. It is a good rule in laying out wainscoting to keep the individual pieces reasonably small and to have the least dimensions transverse to the grain, with the purpose of lessening as much as possible the results of the inevitable shrinkage of the material.

**179. Moldings.**—The moldings used to fasten mirrors in place or to cover joints between tilework and woodwork of the fireplace opening should be screwed in place, so that they can be easily removed.

**180. Door Stops.**—The stops of doors are usually simply planted on jambs. A better job, however, is obtained by housing them into the jambs.

**181. Provisions for Curtain Rods, Rollers, Etc.**—In detailing window trim, etc., sufficient plain surface should be left on which to fasten curtain rods, rollers, etc.

**182. Curved Material.**—Curved moldings for interior work should be carved or run in a machine and not kerfed. Curved panels and plain surfaces should be bent veneer on a built-up white-pine core.

**183. Stock Doors.**—Doors that are kept in stock by dealers may be obtained in almost any size from 6 to 7 feet in height and from 2 to 3 feet in width, the thickness varying from $\frac{7}{8}$ to $1\frac{3}{4}$ inches. They are made of white pine, poplar, cypress, and yellow pine. Some manufacturers carry oak-veneer doors in stock also.

**184. Stock Windows.**—Windows ready for use are made either grooved for cords or plain, as many windows in cheap work are placed without weights. The usual stock sizes are about as follows:

| | | |
|---|---|---|
| Two lights, | $24'' \times 24''$ | In 1- and $1\frac{1}{4}$-inch thicknesses —double hung. |
| Two lights, | $24'' \times 26''$ | |
| Two lights, | $24'' \times 28''$ | |
| Four lights, | $12'' \times 24''$ | In $\frac{5}{4}$-inch thickness — not double hung. |
| Four lights, | $12'' \times 26''$ | |
| Four lights, | $12'' \times 28''$ | |
| Four lights, | $12'' \times 20''$ | |
| Twelve lights, | $8'' \times 10''$ | |
| Twenty-four lights, | $8'' \times 10''$ | |

**185. Painting Door Panels.**—Panels of doors that are to be painted or stained should be treated before being incorporated in the door, so that any shrinkage that may occur will not expose the unstained or unpainted wood, which would be the case if the painting or staining were done after the door is made.

**186. Door Cores.**—The cores of veneered doors are usually made of white pine, ash, or chestnut, as these woods take glue well.

**187. Door Paneling.**—The paneling of a door should be so arranged that the lock will not cut into the tenon of a rail. In Fig. 3, the names of the different parts of a door are given, with the common dimensions of stiles and rails. The hinges should line up with the paneling as indicated.

**188. Proper Swing for Doors.**—Doors leading to pantries, lavatories, bathrooms, and bedrooms should swing in such a way that the greater part of the room will be hidden until the door is wide open. Closet doors should open in a direction that will give the most light to the closet from windows and lighting fixtures. Outside doors to public buildings should open outwards.

**189. Sliding doors** are hung on tracks and hangers, of which there are a number of makes on the market.

**190. Entrance Side Lights.**—The lights placed at the sides of entrance doors should not be wider than 8 inches if of leaded glass, as they would afford easy access to a burglar. Other large leaded-glass lights in accessible positions should be avoided for the same reason.

**191. Double-acting doors** are pivoted top and bottom, and various types of spring hinges are made for this purpose. The back of the hanging stile should be rounded so that it may be swung close to the jamb and still have clearance. The pivot that is let into the bottom rail of the door is preferable to the type that is sunk in the floor, the latter being liable to become filled with dust or dirt.

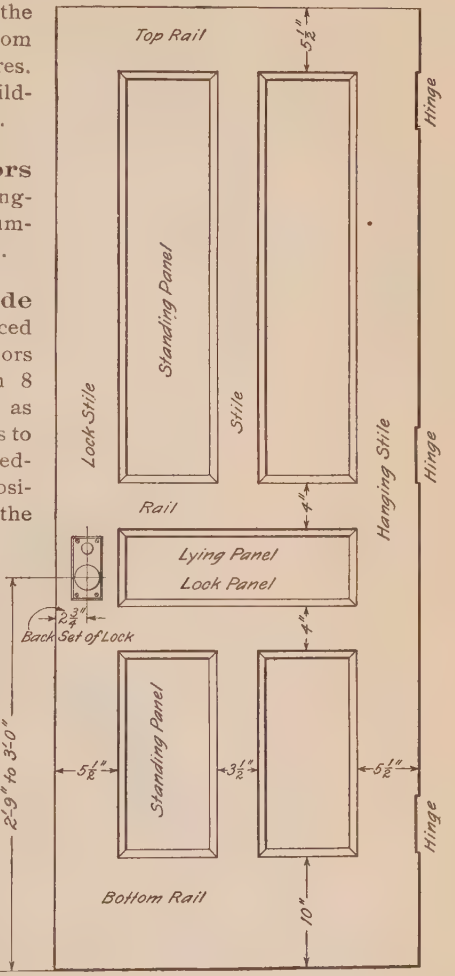


FIG. 3

**192. Glazing Rabbets.**—The sides and backs of glazing rabbets and stops for mirrors, etc. should be painted black, to prevent reflection from the edge of the glass; and for lights of large size the

backs of the stops should have felt glued to the surface of the wood to form a cushion for the glass.

**193. Door Hanging.**—A good appearance is obtained by projecting the face of a door $\frac{1}{8}$ inch beyond the edge of the jamb lining; this covers the joint between the jamb and architrave and gives the hinges more clearance.

**194. Contour of Moldings.**—If the architect wishes the contractor to follow the contours of the moldings exactly as shown on the full-size details, it should be emphasized by distinctly stating that no moldings that are not exactly according to details will be accepted, as the contractor is liable to change the contours somewhat at times in order to save undercuts (see Fig. 6), or a second running through the machine.

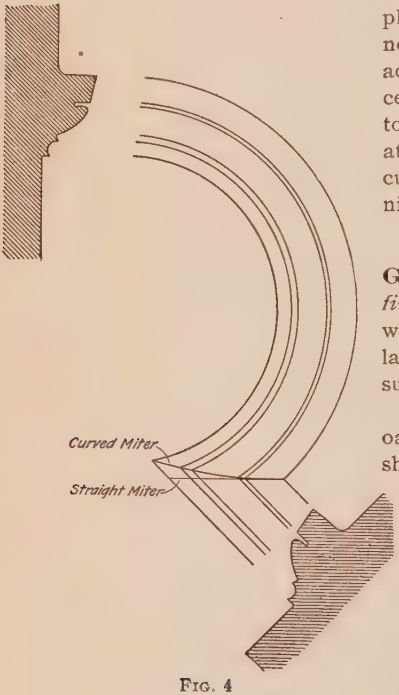

FIG. 4

**195. Fine- and Coarse-Grained Woods.**—Woods of *fine grain*, such as black walnut, white pine, mahogany, and poplar, may be finely molded and are suitable for carving.

Woods of *coarse grain*, such as oak, chestnut, ash, and cypress, should be coarsely molded.

**196. Curved and Straight Moldings.** Where a curved molding meets a straight one in panel or other work, it should be stated whether the miter is to be straight or curved. If the straight miter is used, two different molding sections must be used, as shown in Fig. 4.

**197. Undercut Moldings.**—In designing paneling, etc., it should be remembered that undercut moldings cannot be scribed but must be mitered.

Undercut moldings are more expensive than moldings that can be cut in one run of the machine. In Fig. 6 (*a*) is shown a molding that can be run in one position with one knife and at (*b*) is shown the same molding so drawn that it will require two runs and knives.

**198. Wooden Dowels.**—In the best cabinetwork, wooden dowels and glue are used as much as possible to the exclusion of nails and screws.

**199. Capillary Attraction.**—The tendency of water to work itself between two closely adjacent surfaces, against the force of gravity, known as *capillary attraction*, should be guarded against in window-sash design. The lower rail of the lower sash in particular should be taken care of by throating, and the sill should be well pitched

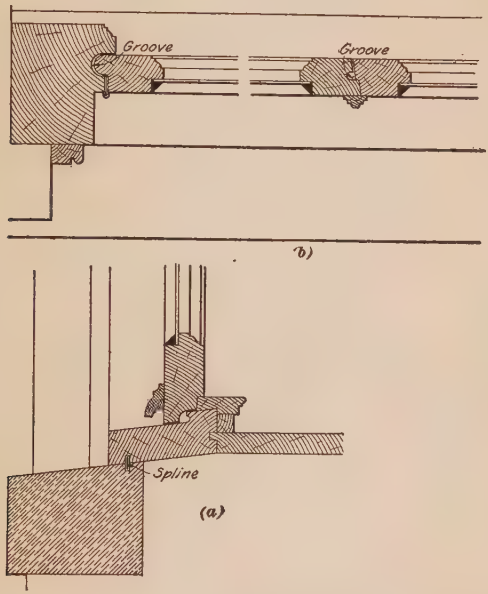


FIG. 5

and rabbeted for the sash [see Fig. 5 (*a*)]. Where French casements are used, the meeting rails should be beveled, rabbeted, and grooved, and the hanging stiles tongued into jambs [see Fig. 5 (*b*)]. The grooves in the jambs and meeting rails should be sufficiently large to allow the water that may work into them to run away.

**200. Position of Casements.**—The washing of a window should always be considered in connection with its position, and casements should be made to swing inwards if possible (although such windows are harder to make storm-tight), as they are easier to wash. A casement on the second floor that swings outwards is almost impossible to wash on the outside, greatly to the annoyance of the housewife.

**201. Window stops** should be fastened in place by stop adjusters, which are metal sockets countersunk into holes bored in the stop and through which the screws fastening the stop go. These sockets are grooved at the bottom, and thus allow the adjustment of the stop in case the sash cramps.

**202. Devices for Large Windows.**—For very large windows where the meeting rails are too high to reach, a turnbuckle catch should be placed on the stile of the lower sash with a strike plate let into the pulley stile. Such sash should also have a countersunk metal socket in the top rail of the upper sash, in order that it may be lowered by means of a wooden rod with a metal hook that fits into the socket.

**203. Metal splines** sunk into wood and stone sills well set in asphalt or other cement, keep water from working back under the sill. See Fig. 5 (*a*).

**204. Skylights** should be protected with wire where there is danger of breakage from falling objects, as at the base of light wells. Where the skylight is not double, provision should be taken to carry away the water of condensation that forms on the under side of the glass. This is done by grooving the sash bars, or muntins, or placing small metal troughs under them. These grooves, or troughs, are led to the lowest point of the skylight and discharged through the curb to the roof.

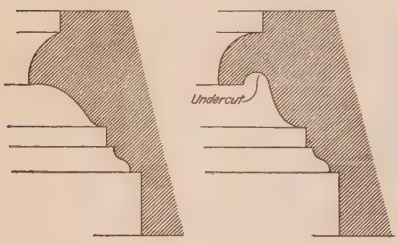

FIG. 6

**205. Painting and Puttying.**—Putty for skylights should contain a non-drying oil that will keep the putty elastic and prevent cracks. Window sash should be painted before puttying. If they are not painted, the wood will absorb the oil from the putty and render it brittle.

Where very heavy sheets of glass are used, they should be *back-puttied*, that is, putty should be placed on the rabbet so as to form a bed on which the glass may rest.

**206. Sash Weights.**—The weights for the upper sash should be at least $\frac{1}{2}$ pound heavier than the sash itself, in order that the sash may be kept tight up against the head. The weights for the lower sash should be about $\frac{1}{2}$ pound lighter in weight than the sash, so that the lower sash will stay down. Spring sash balances are made, which do away with the weights, but they are not reliable.

**207. Weight of Window Sash.**—The weight of white-pine window sash per running foot, is approximately as follows, the meeting rail and top and bottom rails being figured the same as the stiles, as their average width will usually be about the same. For the weight of muntins, if any, add about 4 ounces per running foot.

| | Ounces |
|---|---|
| Sash $1\frac{1}{8}$ inches thick | 7.9 |
| Sash $1\frac{3}{8}$ inches thick | 9.6 |
| Sash $1\frac{5}{8}$ inches thick | 11.34 |
| Sash $1\frac{7}{8}$ inches thick | 13.09 |

## TABLE I

### WEIGHT OF WINDOW GLASS

| Kind of Glass | Grade | Thickness Inch | Weight per Square Foot Ounces |
|---|---|---|---|
| American } double thick | AA | $\frac{4}{32}$ | 32 |
| American } double thick | A | $\frac{3}{32}$ | 22 |
| American } double thick | B and C | $\frac{2}{32}$ | 15 |
| Plate | | $\frac{2}{8}$ | 52 |
| Plate | | $\frac{3}{8}$ | 78 |

## TABLE II

### WEIGHT AND DIMENSIONS OF SASH WEIGHTS

| Length Inches | Diameter of Round-Iron Sash Weights, in Inches | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | $1\frac{1}{4}$ | $1\frac{1}{2}$ | $1\frac{3}{4}$ | 2 | $2\frac{1}{4}$ | $2\frac{1}{2}$ | $2\frac{3}{4}$ | 3 |
| | Weight of Round-Iron Sash Weights, in Pounds | | | | | | | | |
| 1 | .20 | .31 | .45 | .62 | .81 | 1.04 | 1.27 | 1.53 | 1.83 |
| 2 | .40 | .62 | .90 | 1.24 | 1.62 | 2.08 | 2.54 | 3.06 | 3.66 |
| 3 | .60 | .93 | 1.35 | 1.86 | 2.43 | 3.12 | 3.81 | 4.59 | 5.41 |
| 4 | .80 | 1.24 | 1.80 | 2.48 | 3.24 | 4.16 | 5.08 | 6.12 | 7.32 |
| 5 | 1.00 | 1.55 | 2.25 | 3.10 | 4.05 | 5.20 | 6.35 | 7.65 | 9.15 |
| 6 | 1.20 | 1.86 | 2.70 | 3.72 | 4.86 | 6.24 | 7.62 | 9.18 | 10.98 |
| 7 | 1.40 | 2.17 | 3.15 | 4.34 | 5.67 | 7.28 | 8.89 | 10.71 | 12.81 |
| 8 | 1.60 | 2.48 | 3.60 | 4.96 | 6.48 | 8.32 | 10.16 | 12.24 | 14.64 |
| 9 | 1.80 | 2.79 | 4.05 | 5.58 | 7.29 | 9.36 | 11.43 | 13.77 | 16.47 |
| 10 | 2.00 | 3.10 | 4.50 | 6.20 | 8.10 | 10.40 | 12.70 | 15.30 | 18.30 |
| 11 | 2.20 | 3.41 | 4.96 | 6.88 | 8.91 | 11.44 | 13.97 | 16.83 | 20.13 |
| 12 | 2.43 | 3.72 | 5.40 | 7.44 | 9.72 | 12.48 | 15.24 | 18.36 | 21.96 |

**208. Window-Glass Weights.**—The weight of window glass is shown approximately in Table I.

**209. Sash Weights.**—The weights and dimensions of *round iron sash weights* are given in Table II.

*In square-section iron sash weights*, with the side of the square the same as the diameter of the round iron weights just given, the lengths and weights may be obtained by multiplying the values given in Table II by 1.273.

The weights of *lead sash weights* may be obtained by multiplying the weights of corresponding iron weights by 1.58.

**210. Built-in Wooden Seats.**—Cushioned seats should be pitched back slightly, and an upset, which will serve to keep the cushion in place, should be put on the nosing. The height of the seats from the floor should be from 16 to 19 inches if the seats are without cushions, and about 2 inches less if cushions are used.

*Billiard-room seats* should be up one or two steps, so that persons seated upon them may have a good view of the table top.

**211. Seat tops** are often fitted with hinged panels and the interior of the seat used for various purposes. If plaster is exposed inside of the seat, it should be lined with narrow $\frac{5}{8}$-inch ceiling.

**212. Bases.**—In public buildings, bases should be made of slate, marble, glass, or some other non-absorbent material.

**213. Bank Counters.**—The counters used in banks for counting money or at tellers' windows should be covered with plate glass or marble. The proper height for the working counter is about 41 inches. The shelves at the windows are sometimes placed a few inches higher.

**214. Kitchen Fixtures.**—*Kitchen work tables* are usually 2 feet 8 inches from the floor. The *bread board* is often covered with block tin or sheet zinc, or is of marble or glass. The *drip board* of the sink is most convenient on the right-hand side.

**215. Refrigerators.**—Outside ice doors for refrigerators are used and are a great convenience, combining the keeping of the refrigerator inside and avoiding the entering of the house by the ice-man. Refrigerators of standard makes are supplied with these doors, and their size and height from the floor, together with other particulars, may be obtained from the manufacturers. The jambs and casing of these doors should be protected with sheet zinc or copper.

**216. Bookcase Shelves.**—The shelves for bookcases are from 10 to 12 inches deep and should have one coat of varnish. They

should be made adjustable by ratchets and cleats or by strips with holes and pins. The average number of books allowed for each square foot of shelving is nine.

**217. Bookcase and Pantry Doors.**—The doors of bookcases are glazed with plate or leaded glass, and they either slide or are hinged. The hinged doors are preferable, as sliding doors are very difficult to wash on the inside.

For pantry cupboards, sliding doors are not so objectionable, as the contents of the cupboard are usually much easier to remove than books. The space in pantries is limited also, and the swinging doors take up considerable room when open.

**218. Bins.**—Bins for sugar, flour, and salt are usually placed under the counter shelf of the pantry cupboard. They should be provided with vermin-tight covers.

**219. Kitchen Closets.**—Closets for brooms, dust pans, table leaves, and scuttles should be provided for the housekeeper.

**220. Window Blinds.**—Outside blinds should be hung by butts, with sufficient swing to clear the brick or stone jambs or wooden trim, as the case may be. Inside blinds are used in the folding and sliding forms. The first type fold into pockets in the jambs and the second type are counterweighted and slide in guides at the jambs into pockets below the sills.

**221. Rolling partitions,** made of interlocking wooden strips, are manufactured and are much used for the subdivision of Sunday schools and other schoolrooms. They roll either into horizontal or vertical pockets, and are somewhat similar to the rolling shutters of roll-top desks.

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### GLASS

**222. Window Glass.**—The window glass used in buildings is designated as either American plate, art, or obscured glass. **American glass** is the ordinary blown glass, and can be had in four grades, AA, A, B, and C, either double-thick or single-thick. *Double-thick* is between $\frac{3}{32}$ and $\frac{5}{32}$ inch thick, and *single-thick* is thinner. This glass is suitable for ordinary work, but a certain amount of distortion of objects viewed through it is inevitable. It can be obtained in sizes of even inches up to 60 in. × 68 in.

**223. Plate glass** is used in the best work and does not distort objects viewed through it as does the American. This glass is $\frac{2}{8}$ to $\frac{3}{8}$ inch thick and may be obtained in sizes of even inches up to 12 ft. × 17 ft. Where plate glass is used in doors or other places

where it is likely to be jarred, it is sometimes bedded in India rubber, one piece being glued to the glass and the other to the face of the rabbet.

**224. Art glass** is used for church windows, and for decorative windows in residences. All types of glass already mentioned and many other colored, crinkled, or frosted glasses are used in this work. The glass is outlined in different designs by lead or copper mullions.

**225. Obscured glass** is used for windows of lavatories and the like, and is made in several different surfaces, as *ground*, *frosted*, *chipped*, etc.

**226. Wire glass** is used in metal sash where a building is exposed to danger from fire, as in elevator shafts, on sides adjoining other buildings, etc. This kind of glass has a woven wire netting embedded in it, and although it may crack or partly melt under great heat, it will remain in position and prevent fire from breaking through.

**227. Prism glass** is made in individual prism lights that set in a metal framework, used in vault lights, or in sheets cut to any size desired smaller than 7 ft. × 3 ft. 6 in., used for skylights, windows, etc. This glass is usually set in squares of from 4 to 6 inches, and is held in place by metal muntins.

The prisms and sheet prisms are used to throw light, by means of refraction, from between high buildings or over store windows to the interior of buildings, and are a great help to stores or offices of such depth as to be poorly lighted. Prism and prism glass are made by a number of companies, who issue catalogs that clearly explain their uses. Polished plate prisms may be obtained in sheets up to 54 in. × 60 in., and skylight glass in sheets 13 in. × 13 in.

**228. Puttying Windows.**—For iron frames use red-lead putty; bed thoroughly, and back the putty, using felt or rubber to keep the glass from the iron. Putty for wooden sash should be made of pure raw linseed oil and whiting. Tallow is sometimes added where the panes are large and liable to movements due to expansion and contraction. All glass should be bedded in a layer of putty and should be secured by triangular points of sheet zinc, which are covered by the final puttying.

**229. Setting Large Window Panes.**—Store-front panes are set in patent frames or in cast-iron angles with wooden stops, and it is very necessary to keep the glass from coming in contact with the iron; felt, leather, and rubber are used for this purpose. The joints should be made tight with red-lead putty. The stops in this work should be fastened with screws so that they may be easily removed for repairs.

**230. Mullions.**—Mullions, or muntins, for art glass are of several shapes, the common types being shown in Fig. 7. The type shown at (*a*) is made of lead in several sizes and styles, and is called *colonial lead;* (*b*) is the commonly used lead, is called *flat*, and is

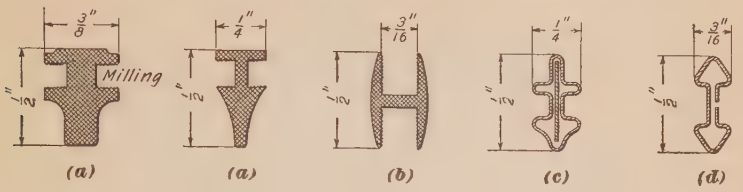


FIG. 7

made in several sizes; (*c*) and (*d*) are of copper or hard metal and are made in several sizes and sometimes reinforced, as shown at (*c*), with a steel strap.

**231. Water-Tight Leading.**—The joint between the glass and the lead muntin is made water-tight by brushing with whiting and red lead and then with black lead. A grip is given to this cementing by the milling on the bearing surfaces of the leading.

**232. Saddle Bars.**—Leaded glass lights are stiffened and often entirely supported by horizontal saddle bars of square or round section. They are made of iron, steel, zinc, or copper, and are wired and soldered to the leading.

Broad lights of more than 30 inches in wooden sash should have the additional support of saddle bars fixed to the frame and wired and soldered to the sash. Vertical bars are called *stanchions*, and horizontal bars, *saddles*.

Saddle bars and stanchions are sometimes let into stone jambs, head and sill.

**233. Art-Glass Skylights.**—Skylights of art glass are used with good effect, but should of course be under and protected by an outer or exposed skylight.

**234. Cloissonné glass** is a recent English invention, and is a pattern of colored enamels confined by metal partitions and mounted on a glass plate, which is covered with a second sheet of glass. The metal partitions are gilded. These panels, while opaque, are very snappy in color. The total thickness varies from $\frac{3}{8}$ to $\frac{3}{4}$ inch, according to the thickness of the plates used. Tin-foil is used to fill between the edges of the plates, and the rabbet of the sash should be high enough to hide this.

**235. Wooden Sash for Leaded Glass.**—For residences, the wooden sash in which leaded glass is to be inserted should be

sent to the manufacturer for that purpose. This is the safest method, and the specification should state that the carpenter contractor is to ship the required sash to the manufacturer and pay the transportation charges both ways.

## PAINTING

**236. Preparation of Woodwork.**—Before painting, woodwork should be seasoned and dry and free from dust, and the quirks and cracks should be thoroughly brushed out. Painting in frosty weather is quite likely to result in blisters, due to small quantities of frost that remain under the paint. All wood should be smooth, and the knots should be thoroughly shellacked.

**237. Outside Priming Coat.**—The priming coat should be of white lead and linseed oil, colored to correspond in tone with the proposed final coat, and should be followed by a thorough puttying of all nail holes, etc. All the finished work possible should be primed before leaving the shop. Built-up columns, balusters, brackets, etc. should always be primed before leaving the shop. Too long an interval should not be allowed between the priming coat and that next following.

**238. Inside Priming Coat.**—White lead makes the best inside priming coat. If zinc white is used, it should be in the second and following coats, as it has not as much body, or filling quality, as white lead. The priming coat should be thin, but not too thin.

**239. Painting Old Woodwork.**—Where old work is to be painted, all loose scales and dirt should first be removed by solvents, scraping, or burning. Where a light color is placed on a darker one, a greater number of coats will be required than if the base color were light or a dark color were placed over a lighter color.

**240. Removing Old Paint.**—Old paint may be removed by means of quicklime, naphtha, wood alcohol, caustic soda, or a spirit lamp.

**241. Putty.**—Putty should be composed of whiting, white lead, and pure linseed oil. The use of oils other than linseed causes the yellow spots over nail heads that are often seen on otherwise good work.

**242. Causes of Blistering and Cracking.**—*Blistering* is due to wet or frosty wood, pitchy spots not properly treated, too much oil in paint used on the surfaces much exposed to the sun's heat, or too little time allowed between coats. *Cracking* of paint is due to too much oil in the under coats and too little in the top coats.

**243. Knotting.**—Shellac is sometimes called **knotting,** because it is used to cover knots before painting to prevent the exudation of sap.

**Shellacked, primed,** and **stopped** mean the knotting, priming coat, and puttying, which makes ready for the second and following coats.

**244. Blackboard Paint.**—Paint used for blackboards may be made with silicate of soda (soluble glass) and water in equal parts, with just enough lampblack added to color it.

**245. Durability of Paint Work.**—Exterior work, when well done, should remain in good condition for about 6 or 7 years; inferior work, however, lasts only about 3 years. Interior work should last from 10 to 30 years, according to how well it is done.

**246. Coats of Paint Required.**—New work should have at least two coats of paint following the priming coat; three coats will give the best results, however.

Painting over old work, if it is in fair condition, will require only two coats of paint, unless the old work is dark and the new is to be light, in which case probably three coats will be needed.

**247. Painting Plastered Walls.**—Newly plastered walls should not be painted or papered immediately; they should stand at least 3 months and should then be coated with a good liquid filler or with thin glue sizing, and the blisters or unslaked spots cut out and stopped before painting or papering is done.

Old painted walls need only be washed thoroughly with soap and water and cleaned of loose scale before painting. Two coats will usually be sufficient. Large surfaces should be *stippled* to obtain a good effect.

**248. Paint for Brick Walls.**—Brick walls will usually take about two coats, with $\frac{1}{2}$ gallon of linseed oil added to each gallon of paint for the first coat.

**249. Paint for Floors.**—Floors are painted with lead-and-oil paint, with varnish added to give the paint a harder and more glossy surface and to hasten its drying

**250. Ironwork Painting.**—Ironwork should be cleaned of rust, scale, dirt, etc. before painting. This is done by rubbing the ironwork with benzine, brushing with wire brushes, scraping, tapping with hammers, or burning with a spirit torch. The durability of the paint applied to ironwork depends very much on the care with which this cleaning is done.

**251. Distemper Paints.**—Distemper or cold-water paints are used for painting wood, stone, or brickwork, and are made of pigment mixed with water and glue, or some other like substance for a binder.

Distemper paints are much darker when first applied, becoming lighter in drying out. Enough mixture should be provided to do an entire room at one time, as it is very difficult to match a tint in making a new supply of paint. *Washable distempers* have just enough oil in them to be insoluble in water. The relative cost of distemper, washable distemper, and oil paint is about 1 to 2 to 3.

**252. Fire-Retarding Paint.**—A fire-retarding paint may be had by using alternate coats of silicate of soda and lime wash. Tungstate of soda and asbestos paints are also used.

**253. Applying Paint.**—Paint should be put on with strokes parallel with the grain, and, where possible, the painter should make the strokes the full length of the pieces.

Hardware may be saved the daubing and spattering by painters if it is fitted and then removed until the painting is done, when it is again replaced. The window glass should also be protected from spattering paint, which is sometimes difficult to remove.

A gloss may be given to a paint by the addition of copal, or other oil varnish.

**254. Paint for Roofs.**—Tin roofs and ironwork are painted with red metallic paint (oxide of iron in linseed oil), graphite paint (graphite in linseed oil, with dryer), or P. B. paint (asphaltum, linseed oil, turpentine, and Kauri gum). Metal work may also be painted with lead and oil with good results.

**255. Cleaning Paint Work.**—To clean paint work, rub with a paste of whiting, and afterwards wash and rub dry with a soft cloth.

**256. Fillers** are composed of linseed oil, japan, and some base that is non-absorbent, such as ground glass or corn starch. This compound should be fairly translucent; it should not be diluted, and should be frequently stirred to keep the binder distributed. Fillers are used to fill the open portions of the grain in the wood, so as to obtain an even and impervious surface for the varnish coat. They should be well rubbed into the pores.

**257. Stains** are preparations in liquid form that are applied to woods for the purpose of imitating other more expensive woods or for unique color effects. Where stains are used to alter the colors of open-grained woods, the stain is mixed with the filler, the balance of the finishing being done as described for natural finish. Stains should not contain fatty oils nor acids that will act on the varnish.

**Shingle stains** are made in a great variety of colors by several concerns.

**Water stains** raise the grain, and unless this is desired, they should be avoided.

**258. Glue size** may be prevented from decomposition by the addition of a little carbolic acid or essence of peppermint or cloves.

**259. Varnishing Temperature.**—Varnishing should be done in a temperature of about 70° F. that is as free from moisture as possible.

**260. Dull and Bright Finish.**—A good job of varnishing may be obtained with two or three coats of varnish besides the filler. If a dull surface is desired, the under coats should be rubbed down with sandpaper or curled hair to take off inequalities, and the last coat with pumice or rottenstone and oil or water. If a bright gloss is desired, the last coat should not be rubbed, or only very slightly. Care should be taken to clean the pumice, etc. out of quirks, cracks, etc.

Dull surfaces for varnish may also be obtained by the use of *dead varnishes*, or those containing wax or other substances that give a surface similar in appearance to a rubbed varnish. Paint may be rubbed to a dull surface in the same manner as given for varnishes.

**261. Wax Finish.**—Where a wax finish is desired on a varnished surface, use beeswax dissolved in turpentine, to the consistency of oil. This is applied with a brush, and after being dried, is followed with a coat of the consistency of clotted milk. This coat should be rubbed with a soft cloth until dry.

**262. Varnishes** are solutions of different gums in oil, turpentine, or grain alcohol. Turpentine is employed for thinning varnish, but should be used sparingly.

**263. Varnishing Close- and Open-Grained Woods.** Close-grained woods to be varnished should be filled with a shellac varnish. Woods of this nature are white pine, Georgia pine, poplar, cypress, California redwood, maple, etc.

Open-grained woods to be varnished should be filled with a paste filler, colored according to the wood or stain. Woods of this kind are oak, ash, walnut, mahogany, chestnut, etc.

Redwood is very susceptible to linseed oil, which makes a chemical combination with the acids in the wood. Therefore, no linseed oil should be used in fillers, varnishes, or paints used on this wood. Shellac may be safely used.

**264. Floor Varnishing.**—Floors to be varnished are first filled with shellac or paste filler, and then given two coats of floor

varnish. The finishing coat may be left glossy or rubbed to a dull finish with pumice and oil. Varnish is sometimes used instead of filler.

**265. Specifying the Varnish.**—The architect should decide on some good varnish to be used and determine by tests that it is pure. This varnish should be specified by its name or number, and the architect should insist on its being delivered at the building in sealed packages.

**266. Linseed oil** is recognized as preeminent for use in paints, but as there are a great number of other drying oils and about thirty non-drying oils to be had, it is evident that the purity of the linseed oil used is a matter of great importance and one that the architect should look into thoroughly.

**267. Boiled oil** is a combination of raw oil and driers boiled, which improves the drying qualities of the oil. Boiled oil dries in about one-half the time that it takes for raw oil. It is used for interior work and in grinding colors. Boiled oil is also used for outside work, and it gives a gloss to the paint; it is much darker in color than the raw oil.

**268. Enamel Paints.**—White-enamel paints that dry with a gloss are made. They are placed on a foundation of successive coats of white lead or white lead and zinc white. In best work, the coat immediately beneath the enamel should be of zinc white.

**269. White lead** is principally lead carbonate with from 15 to 25 per cent. of lead hydrate, and as sold to the customer is ground in linseed oil. It is made either by the *corrosion process*, by the *precipitation process*, or is *sublimed*, and varies considerably in the proportions of the component parts. Pure white lead is ropy when lifted from the pail with a knife.

The adulterants used in white lead are sulphate of lead, sulphate of lime, whiting, chalk, zinc white, etc.

**270. Zinc white** and **poppy oil** are used for all the French government work. Zinc white is a hydrated zinc carbonate or oxide, and is suitable for interior work. It has not as good covering qualities as lead, and should have a small amount of white lead mixed with it.

**271. Red lead** is an oxide of lead prepared by heating massicot in a furnace. The adulterants used are oxide of iron, brick dust, etc. Oxide of iron is made from iron ore. Red lead is also made from litharge.

**272. Coloring Paints.**—The different colored paints are obtained by mixing the various color pigments with white lead or zinc white and linseed oil, except the metallic paints, which use an inert

pigment with oil and a drier, the color being usually controlled by the pigment.

**273. Drying and Non-Drying Oils.**—Linseed oil, poppy oil, hemp oil, etc. are drying oils. Non-drying oils are cottonseed, olive, castor, etc., and are not suitable for paints or varnishes, as they do not dry and also contain elements that decompose.

**274. Turpentine** is a product of distillation of the sap obtained from the long-leaved yellow pine, rosin being the residue. Turpentine is used as a thinning agent and to dull or flatten paints and varnishes.

**275. Shellac** is a spirit or alcohol varnish, the **white shellac** being a solution of bleached lac, while the **orange shellac** is the natural color of the lac. *Grain alcohol* should be used, not *wood alcohol*.

**276. Rosin** dissolved in turpentine is used for cheap varnishes, but makes a very inferior finish that will scratch white.

**277. Japan drier** is made of shellac and linseed oil cooked together with a drier added. It is thinned with turpentine.

**278. Driers** are substances such as litharge, sugar of lead, antimony, and sulphate of zinc, and are used to hasten the drying of varnishes or paints. They should be used with moderation.

**279. Naphtha, benzine,** and **petroleum** are mineral oils used as solvents in bituminous, asphalt, and coal-tar paints.

**280. Ready-mixed paints** are made in great variety, but should be used with caution.

**281. Fugitive Colors.**—The following oil colors are fugitive and should be avoided:

| | | |
|---|---|---|
| Violet carmine | Green lakes | Prussian blue |
| Burnt carmine | Indigo | Prussian green |
| Yellow carmine | Italian pink | Rose lake |
| Carmine | Magenta | Sap green |
| Citron yellow | Mauve | Verdigris |
| Crimson lake | Olive lake | Yellow lake |
| Gamboge | | |

## HARDWARE

**282. Specifying Hardware.**—Hardware manufacturers issue voluminous catalogs from which the architect may select and specify locks, butts, and other necessary hardware with great exactness. He should therefore obtain the catalogs of the reliable firms and make selections therefrom.

**283. Stop-Adjuster.**—A stop-adjuster should be used to fasten window stops. These adjusters allow slight changes in the position of the stops to take care of any shrinkage that may occur.

**284. Sash Appliances.**—Cheap **sash pulleys** or spring **sash balances** should be avoided in good work.

A great many **sash locks** are manufactured, and care should be taken in making a selection to get one that pulls the sash firmly into position when locked and which cannot be thrown by slipping any instrument between the meeting rails.

The best quality of **cord** or **chain** should be selected for hanging windows.

**Pivots** for sash are now manufactured which make it possible to revolve the sash either at the center of the hanging stiles, or, at the center of top and bottom rails. This enables the washing of the entire window from the inside, and does away with weight boxes.

**285. Window weights** in common use are made of cast iron, and are about $1\frac{3}{4}$ inches in diameter with a perforated and flattened end through which the cord or chain is fastened. No particular weight is specified as a rule. Sectional interlocking weights that are rectangular instead of round are now made. They are built up from below, to correspond with the weight of the sash. See Arts. **207, 208,** and **209.**

**286. Casements** should be fitted with **rod adjusters,** by means of which the sash may be fixed rigidly when open and thus be prevented from banging in the wind.

**287. Door butts** should have swing enough so that the door will clear the trim when wide open, and the number of butts should be sufficient to carry the door. Doors over 7 feet high or 4 feet wide should have three butts. The loose-pin butt is preferable to the fast-joint butt, and should have not less than five knuckles.

**288. Locks.**—The number of **keys** desired for each lock and whether or not master keys are desired should be stated in the specification. For very cheap work, rim-tumbler locks are suitable. For the best work, mortised-tumbler or cylinder locks should be used. The greater the number of tumblers, the greater is the security.

**289. Door Checks.**—Where doors are used frequently and are liable to be left open, door checks should be used. These checks contain springs that throw the door shut and oil or air cushions that take the impact and allow the door to close gently.

**290. Door Hinges.**—Double-acting door hinges are used for doors between pantry and dining room or pantry and hall, etc. Such

doors should have push plates, and should be fitted with hooks and eyes to fasten them open if necessary.

**291. Door bumpers** of wood or metal with rubber tips are usually placed behind doors to prevent the doors from bumping the base boards.

**292. Door hangers** with track for sliding doors are made in a number of types, and care should be taken in making a selection. Noiselessness, strength, and adjustability are points to be considered.

**293. Strike Plates.**—Where security is an essential point and stops are not housed into the jamb, a protected lock-strike should be used. This strike plate has a projection that covers the crack between the wooden stop and the jamb, through which a knife blade or a thin paper cutter may be thrust to throw back the latch. The rabbeting of the stop into the jamb of course obviates the necessity for the use of such a strike.

**294. Door knobs** are made of glass, china, wood, and metal, and are usually flattened spheres or ovals. Mahogany doors are often fitted with cut-glass knobs, which present a very rich appearance.

**295. Terms Applied to Swing of Doors.**—In considering the swing of a door, one is always supposed to be standing outside. A *left-hand reversed door* is one swinging out and to the left. A *right-hand reversed door* is one swinging out and to the right. A *left-hand regular door* is one swinging in and to the left. A *right-hand regular door* is one swinging in and to the right. Ordinary bedroom doors are left- and right-hand regular.

**296. Door Bevels.**—The hand of a door has much to do with the bevel of the latch bolt or the front of the lock where the stile is beveled. Some locks are made reversible; that is, they may be used regular or reversed.

The meeting rails of sliding doors are either beveled, beveled astragal, rabbeted, or plain, and this should be kept in mind in ordering or specifying the locks.

The usual bevel for doors is $\frac{1}{8}$ inch in $2\frac{1}{4}$ inches. It should be stated whether the doors have beveled edges or plain.

**297. Butts for blinds** should have swing enough so that the blind may be thrown back against the building and fastened in that position. An adjuster is now made by means of which the blinds may be opened or shut from the inside of a room without opening the window.

**298. Style of Hardware.**—The finished hardware for a modern interior may be had in any style to harmonize with the style

of the rooms, and the surface finishes afford a very wide choice. In specifying hardware for special conditions, it is best to consult with a practical hardware man, as improvements are constantly being made, which may escape the notice of the architect.

**299. Kicking plates** should be placed on swinging doors in public dining rooms, between pantries and the dining room.

**300. Iron Nails.**—Iron nails are either *cut*, *wire*, *wrought*, or *cast*. Wrought nails are rarely used. Nails are graded by their lengths. They are made from 1 to 6 inches long, or from twopenny to sixtypenny.

**301. Nail Sizes.**—The sizes of nails used for different purposes are as follows:

| | Size, in Pennies |
|---|---|
| Framing | 10, 20, 40, and 60 |
| Sheathing, rough flooring, cross-bridging, etc. | 10 |
| $\frac{3}{4}$-inch ceiling and flooring | 8 to 10 |
| $\frac{1}{2}$-inch ceiling and flooring | 4 to 6 |
| Inside finish | 2 to 8 |
| Clapboards | 6 |
| Shingles, slating, lathing, etc. | 4 |

Lathing nails are usually of cast iron.

**302. Copper** and **zinc nails** are also made, and are used in wet positions or where iron would not be suitable because of its magnetic action.

**303. Screws** are made of iron, steel, copper, bronze, brass, and phosphor-bronze. The ordinary screw is of iron, and may be electroplated to match the different hardware finishes, and have round, oval, or flat heads.

For finished woodwork, where expense will allow it, screws are to be preferred to nails.

**304. Screw Gauge.**—The American screw gauge should be used in specifying screws, which varies from 0 to 30, with diameters from .0578 to .4526 inch. The lengths vary from $\frac{1}{4}$ inch to 6 inches.

**305. Lagscrews,** used sometimes for framing, are made from $\frac{5}{16}$ to 1 inch in diameter and from $1\frac{1}{2}$ to 12 inches in length.

**306. Hand-rail screws** are used to fasten together different parts of stair hand rails, and are $\frac{3}{8}$ and $\frac{5}{16}$ inch in diameter and 4, $4\frac{1}{2}$, and 5 inches long. They are threaded at both ends, and have a square nut at one end and a notch-edged nut at the other. The latter nut is used to tighten up the bolt through a hole in the rail after the bolt is in place.

**307. Expansion bolts** are made of iron, brass, and bronze in many different patterns, and are used to fasten wood or other work to brick or stone. They consist of a bolt having either a screw or bolt head, which screws into a shell divided longitudinally into parts that spread as the bolt advances, thus causing the shell to grip the sides of the hole. These bolts vary from $\frac{1}{4}$ to 1 inch in diameter.

**308. Adhesive Strength of Wire Nails.**—The adhesive strength of smooth wire nails clean or dipped in asphalt, as ascertained by tests made at the Watertown Arsenal, Massachusetts, for the J. C. Pearson Company, is given in Table III. (Nails driven perpendicular to the grain of the wood; all nails driven in the same stick.)

**TABLE III**

**ADHESIVE STRENGTH OF WIRE NAILS**

| Description of Nails | | | | Length Driven Nails | Total Adhesive Resistance Pounds | Average Pounds |
|---|---|---|---|---|---|---|
| Name | Size Pennies | Diameter Inch | Total Length Inches | | | |
| Common smooth | 10 | .145 | 2.99 | 2.50 | 136 | 167 |
| Common smooth | 10 | .145 | 2.99 | 2.50 | 144 | |
| Common smooth | 10 | .145 | 2.99 | 2.50 | 220 | |
| Coated . . . . . | 10 | .117 | 3.00 | 2.50 | 414 | 418 |
| Coated . . . . . | 10 | .117 | 3.00 | 2.50 | 406 | |
| Coated . . . . . | 10 | .117 | 3.00 | 2.50 | 435 | |
| Common smooth | 9 | .132 | 2.83 | 2.25 | 226 | 182 |
| Common smooth | 9 | .132 | 2.83 | 2.25 | 125 | |
| Common smooth | 9 | .132 | 2.83 | 2.25 | 196 | |
| Coated . . . . . | 9 | .114 | 2.68 | 2.25 | 345 | 327 |
| Coated . . . . . | 9 | .114 | 2.68 | 2.25 | 318 | |
| Coated . . . . . | 9 | .114 | 2.68 | 2.25 | 317 | |
| Common smooth | 8 | .132 | 2.52 | 2.00 | 146 | 189 |
| Common smooth | 8 | .132 | 2.52 | 2.00 | 228 | |
| Common smooth | 8 | .132 | 2.52 | 2.00 | 192 | |
| Coated . . . . . | 8 | .112 | 2.39 | 2.00 | 322 | 316 |
| Coated . . . . . | 8 | .112 | 2.39 | 2.00 | 318 | |
| Coated . . . . . | 8 | .112 | 2.39 | 2.00 | 309 | |
| Common smooth | 6 | .097 | 2.05 | 1.625 | 100 | 106 |
| Common smooth | 6 | .097 | 2.05 | 1.625 | 112 | |
| Common smooth | 6 | .097 | 2.05 | 1.625 | 105 | |
| Coated . . . . . | 6 | .092 | 1.94 | 1.625 | 214 | 226 |
| Coated . . . . . | 6 | .092 | 1.94 | 1.625 | 218 | |
| Coated . . . . . | 6 | .092 | 1.94 | 1.625 | 247 | |

**309. Holding Strength of Screws.**—The force required to withdraw an ordinary 2-inch screw driven through a $\frac{1}{2}$-inch hardwood board and into a hardwood block has been found to be 790 pounds, and 395 pounds when soft wood was used.

**310. Holding Strength of Cut Nails.**—A cut nail is harder to drive than a wire nail and has a greater adhesive strength, but loses about 40 per cent. of its adhesive value when slightly started. In a series of tests made at the United States Arsenal, cut nails were found to possess more holding power in every case than wire nails.

**311. Facts About Nails.**—The *point* on a cut nail adds 30 per cent. to its holding power, and on a wire nail, about 100 per cent.

Where much vibration is to be encountered in timber work, the wire nail is probably the better to use, as it is less easily loosened than the cut nail.

The holding strength of a nail increases with its length, but not according to any simple law.

Nails driven *across* the grain hold better than nails driven *with* the grain.

**Barbed nails** should not be used, as the barbs decrease the holding power.

## STRUCTURAL IRONWORK

**312. Skeleton Steel Construction.**—Where skeleton construction is used, after the general layout of the building has been determined on, a structural engineer is called in, who lays out the framing plans to suit the conditions of the design, figuring the weights and dimensions of the beams and columns and the sizes of their supporting piers and foundations, according to the loads they will have to carry.

**313. Ordinary Construction.**—In ordinary construction, where a steel beam to span an extra-wide opening is used only occasionally, or the structural work is of a simple character, the services of an engineer are hardly needed.

**314. Beams.**—The steel companies issue handbooks that contain tables which enable the architect or the engineer to pick out suitable steel beams for given conditions.

To avoid excessive deflection, the relation of the span to the depth of a steel beam should be as follows: Depth of steel beam, in *inches*, should not be less than one-half of the span, in *feet*. Where extra strength is required and the depth of a beam is limited, two beams bolted together may be used; or, if the depth is not a consideration, a plate girder may be used.

**315. Lintels.**—Cast-iron lintels over 4 feet in length should not be used.

**316. Girders.**—The depth of a plate girder should not be less than one-fifteenth of the span.

**317. Flitch girders** are used in mill or slow-burning construction where extra strength is required. They are composed of two wooden girders bolted on each side of a steel plate. The strength of this type of beam is difficult to calculate, as the two materials composing it do not act uniformly.

**318. Bearing plates** for beams or girders should set back slightly from the face of the wall, in order that there may be no tendency to crack or chip the corner from the brickwork or stonework. Where *stone corbels* are used for the bearing of steel beams or girders, they should have the front edge chamfered for the same reason.

**319. L and T Trusses.**—For spanning wide openings, trusses composed of steel L's and T's may be built. For a given strength, they are much lighter and cheaper than wood.

**320. Columns.**—Cast-iron columns are suitable for ordinary work, but built-up columns of different rolled-steel shapes are the best. The manufacturers' handbooks give the strength of various sizes and lengths of rectangular and round cast-iron columns, but, as a rule, the built-up columns must be figured.

**321. Strength of Columns.**—Columns vary considerably in strength, according to the method of securing the ends. If both ends are fixed, the column will be much stronger than if either both ends are loose or only one end fixed. The importance of firmly bedding column bases is therefore easily seen.

**322. Wind bracing** should be provided for in a building that is more than twice its least dimension in height.

**323. Necessity of Painting Ironwork.**—Structural cast iron or steel should be thoroughly painted with two coats of an iron-oxide paint before being shipped, and as soon as it is erected, should be given two additional coats. Before applying the first coat of paint, all scale and rust should be entirely removed, for if any particles remain, they will cause the paint to peel off. This cleaning of the surface of ironwork is of the utmost importance and it is seldom done thoroughly. If the steel delivered at the building shows any signs of scale, etc. under the paint, it should be cleaned of both paint and scale and repainted. Where possible, the structural ironwork in a building should be painted, where it is exposed, every 3 to 5 years.

**324. Jambs and Saddles.**—Cast-iron jambs and saddles are used at elevator and other doors in warehouses, factories, etc. where there is considerable trucking.

## ORNAMENTAL METAL WORK

**325. Metal Work.**—In architectural work, ornamental metal work, outside of lighting fixtures and builders' finished hardware, includes cast- and wrought-iron work and cast bronzes or brass.

**326. Cast-Iron Work.**—Cast iron is used in this connection for window frames and mullions, sills, stairway newels, strings, balusters, panels, tracery, grille-work, etc.

**327. Patterns for Castings.**—The patterns, or models, used for making castings are generally of wood, but are also of plaster of Paris, or even of bronze or iron where a great many castings are to be made. For large work, wooden patterns are used. Patterns for fine work, such as ornamental moldings, capitals, etc., are modeled first in wax or clay, from which a casting is made in plaster of Paris. This casting is used in making the mold.

**328. Drawings for iron castings** should be made with a shrinkage rule, which is so divided that each foot is equal in length to $12\frac{1}{8}$ inches standard. This insures that the casting will be of the proper size after it has cooled, as the shrinkage is usually about $\frac{1}{8}$ inch to every lineal foot.

**329. Shrinkage of Metals.**—The shrinkage, in casting, of metals other than iron is as follows:

| Metal | Inch Per Foot |
|---|---|
| Copper | $\frac{3}{16}$ |
| Lead | $\frac{1}{8}$ |
| Aluminum | $\frac{3}{16}$ |
| Brass | $\frac{3}{16}$ |
| Steel | $\frac{1}{4}$ |
| Tin | $\frac{1}{12}$ |
| Zinc | $\frac{3}{16}$ |

**330. Wrought-Iron Work.**—Wrought iron is used for bank grilles, elevator enclosures, elevator cages, window guards, gates, fences, lamps, balcony railings, stair railings, ornamental wall anchors, chimney anchors, finials, ornamental strap hinges, etc.

An attractive surface for wrought-iron work where used for wall anchors, shields, torches, or the like, is obtained by allowing the natural hammer marks to remain.

**331. Methods of Fastening Ironwork.**—Square-head bolts, screw-head bolts, countersunk-head bolts, button-head bolts, tap bolts, lagscrews. and expansion bolts are used to fasten wrought- and cast-iron work.

Iron fences are fastened to stone copings or to stone posts in the ground by means of melted lead, cement, sulphur, or rosin. Lead, however, is best for this purpose.

**332. Molding Ironwork.**—Moldings in cast or wrought iron should not have too fine members or deep quirks, but should be rather plainly and coarsely molded.

**333. Bronze Work.—Cast bronze** is used for memorial tablets, busts, statues, lamps, sun dials, hinges, etc.

Exposure to the weather produces a considerable change in the appearance of bronze. This is due to oxidation, and the coating formed is called the *patina*, which protects the metal from further oxidation.

Bronze tablets or other bronze work should be fastened to stonework or brickwork with bronze expansion bolts, the heads being covered with rosettes or buttons.

**334. Phosphor bronze** is a bronze containing a certain amount of phosphorus, which adds greatly to its hardness. It would be suitable for foot-scraper blades, bearings, hinges, door-knockers, special bolts, etc.

**335. Brass Work.—Wrought brass** is applicable to most of the purposes of wrought iron, though of course more expensive. The bright polish taken by brass renders this metal invaluable in some classes of decorative work, such as internal grilles, balustrades, finished hardware, etc.

**336. Polished brass** as a trim for cast bronze makes an attractive combination. Turned and polished brass or bronze should not have very deep or sharp fillets or quirks, as they are difficult to get at with the buffer and must be polished by hand, thus adding much to the expense.

**337. Gun metal** is an alloy of copper and tin, and does not suffer on exposure to the weather.

Brass, bronze, or gun metal may be turned in the lathe.

**338. Metal-Work Manufacturers.**—The manufacturers of ornamental metal work in this country do very fine work both in wrought and cast metal, and the technical side of the work may well be left to them. Books containing photographs of their best work are published by these manufacturers.

**339. Painting Ornamental Ironwork.**—All ironwork should be painted with iron-oxide, bituminous, tar, or oil paint, according to its location.

For interior grilles, etc. wrought and cast iron may be painted in imitation of bronze with very good effect.

## SHEET-METAL WORK

**340. Metals Used for Sheet-Metal Work.**—Sheet metals as now used comprise tin, copper, iron, zinc, and lead.

**341. Tin.—Tin plate,** which is sheet steel or iron coated with tin, is used principally for roofing purposes. It is also used for leaders, gutters, hot-air pipes, speaking tubes, etc.

**342. Terne plate** is sheet steel coated with a mixture of lead and tin in about the proportion of one of tin to two of lead. This is cheaper than tin plate, and is claimed to better endure the seashore climate. It is a good plate if well coated.

**343. Grades and Sizes of Sheet Tin.**—The different grades of tin plate are designated by the weight of 112 $14'' \times 20''$ sheets, which is the usual number of sheets in a box. The most common grades are designated as IC and IX; the former weighs from 107 to 120 pounds and the latter from 135 to 150 pounds. Sheets 20 in. $\times$ 28 in. are also made, which should weigh twice as much per box; the sheets are stamped IC or IX. The thickness of the coating adds to the durability of the tin plate, but the thickness of the plate does not. Terne plate weighs about the same as ordinary tin plate. Tin plate is also made in $14'' \times 10''$ sheets and other sizes, but these plates are not used so generally as the sizes just stated.

The sheet steel or iron on which the tin coating is placed should weigh from 95 to 100 pounds to the box for IC, $14'' \times 20''$ sheets, and 125 to 130 pounds for IX. The proper weight of the coating per box can be found by subtracting these values from the ones just given.

In making a selection of roofing tin, the architect should investigate the methods of manufacture, so as to learn the quality and thickness of the plate and coating.

**344. Laying Tin Roofs.**—*Standing seams* are used for tin roofs with a pitch of from about 3° to 12° to 7° to 12°. *Flat seams* are used for pitches up to 3° to 12°.

Rosin should be the only flux used in soldering tin roofs, and the solder should be what is termed *half-and-half*, or half tin and half lead. All rosin, etc. should be cleaned from the roof before painting.

**345. Painting Tin Roofs.**—The painting of tin roofs should be done immediately after laying. If the surface of the tin is so oily as to prevent the proper adhesion of the paint, it should be washed with strong soap and water and thoroughly dried before painting. A tin roof should not be allowed to remain unpainted in order that the oil may evaporate or be washed off by rain; this is a very common but

reprehensible practice. The under side of the tin, also, should always be painted.

**346. Flashings.**—Counterflashings should be of sheet lead or copper rather than of tin, as the process of placing these flashings, if of tin, whether built in or fastened by means of hooks, is liable to scrape off the coating.

**347. Gutters and Valley Tin.**—Gutters, valleys, etc., where tin is under more or less wear, should be of the heavier coated tin. Down spouts should be of sheet lead. (Tinned-iron nails should be used to fasten tin.)

**348. Copper Roofing.**—Copper roofs are probably best laid with roll, cleat, or standing seam, unless flat, when a lap seam soldered and fastened with cleats is best. In all these cases, the great expansion and contraction of this metal should be kept in mind and provided for by using double-locked seams, clips, etc.

Copper is probably the best material available for roofing purposes on account of its toughness and durability.

Sal ammoniac is used as a flux for copper soldering, and half-and-half for solder.

**349. Sheet-Copper Grading.**—Sheet copper is graded by thickness and weight per square foot. It is made in from .181-pound to 20-pound weights.

Window frames and sash are made of 16- or 18-gauge copper, which is about $\frac{1}{16}$ inch thick; wire glass is used with these sash. Such sash are used in fireproof construction.

**350. Sheet iron** is made in sheets that are from $\frac{1}{80}$ to $\frac{3}{10}$ inch thick and weigh from 8 to 192 ounces per foot. Galvanizing adds about $2\frac{1}{2}$ ounces per square foot, and corrugating adds about .4 ounce. It is used for roofing and siding warehouses, storehouses, and similar buildings, and should be painted with oxide-of-iron paint.

**351. Sheet Zinc.**—Zinc is seldom used for roofing, as it expands and contracts more than any other roofing metal. Its surface is protected in a manner similar to bronze; that is, patina forms on its surface and prevents further oxidation. Pure sheet zinc, however, if properly laid, makes a very durable roof.

Sheet zinc is made in sheets that weigh from 10 to 20 ounces per foot, or are from .031 to .076 inch thick.

**352. Laying Sheet Zinc.**—The methods of laying zinc roofing are similar to those used for copper. Paper should be laid under zinc, as it is very susceptible to wood acids. No other metals should be used in connection with zinc because of the liability to

chemical action and the great amount of difference in expansion and contraction of the different metals. Zinc nails should be used.

Work tables for kitchens are often covered with sheet zinc or block tin.

**353. Sheet lead** may be obtained in sheets that are from $\frac{1}{25}$ to $\frac{1}{5}$ inch thick and weigh from $2\frac{1}{2}$ to 12 pounds per foot. It is usually designated by weight per foot, and is used principally for counterflashing and roofing.

**354. Lead Roofing.**—Roofs covered with sheet lead should not have a pitch of more than 1 inch to the foot, and the boarding upon which it is laid should be matched, running with the pitch, and blind-nailed. Expansion and contraction should be provided for, and the general methods of laying are the same as for copper.

**355. Gutters.**—Gutters are either *hanging*, *box*, *roof*, or *parapet*.

**Hanging gutters** are always preferable where it is possible to use them. They can be made of tin, copper, or galvanized iron.

**Roof** or **box gutters** may be of tin, copper, zinc, or lead, and should be large in size and have ample pitch. The pitch of gutters should not be less than 1 inch in 10 feet.

All gutters except those made of copper should be painted on both sides.

Wire baskets, which are used to protect down-spout openings in gutters, should be made of copper wire.

**356. Hangers for Gutters.**—Stock hangers are made, by means of which hanging gutters are fastened in place. Wrought-iron brackets that support the gutter from below and also serve as a decorative feature are used in England.

**357. Leaders.**—Corrugated-iron or copper leaders should be used, and they should have 1 square inch in section for each 200 to 250 square feet of roof area drained. No leader with an area less than that of a 2-inch round pipe should be used.

Leaders are usually fastened by expansion bolts or patent hangers. Sometimes, however, decorative straps in connection with expansion bolts or screws are used to support leaders; but more frequently these straps simply cover the hanger or other means of support.

**358. Rain-water heads** are used at the tops of leaders and cover up the bends that issue from cornices. The tops of these heads should be covered so as to prevent birds from building nests in them. Stock designs are carried by some dealers, but, as a rule, special designs are more acceptable.

**359. Leader-Pipe Bases.**—For leader pipes, cast-iron bases that are very neat in pattern are now manufactured. Leaders are cemented into these bases. This makes a much better appearance than where the cast-iron pipes are extended above grade with the leaders cemented into them. These cast-iron bases are calked into the hubs of the cast-iron sewer pipes below.

In climates where severe winters cause the water in leaders to freeze and thus clog them with ice, steam jets are often used. These jets are run into the bases of leaders, and when necessary, steam is turned on to keep the columns of air in the pipes warm enough to prevent any blocking.

**360. Cornices.**—Metal cornices are made of copper and galvanized iron, and are fastened to the building by wooden or iron lookouts. Copper is the best material to use. If galvanized iron is used, it should be thoroughly painted on both sides. Iron lookouts used for this work should have two good coats of iron-oxide paint. Copper cornices do not require painting, as the patina that forms on the copper is sufficient protection.

Copper and galvanized-iron cornices are often formed with a milled or imitation tooled surface, which, after being painted, is sprinkled evenly with white sand while the paint is still wet. When dry, this makes a fair imitation of stonework.

**361. Solder spots** on a copper cornice should be copper-plated in order that they may not show on the surface after the patina has formed, or else all joints should be riveted with copper rivets.

**362. Other Sheet-Metal Products.**—Imitation tile, siding, brick, etc. are now made in copper, tin, and galvanized iron. Work of this kind in tin and galvanized iron should be thoroughly painted on both sides.

Coping coverings, chimney caps, balustrades, outside light standards, candelabra, flagpole bases, etc. are made of copper and galvanized iron.

**363. Fire-doors** and **fire-shutters** are made of wood covered with sheet tin or copper, no solder being used for seams; asbestos cloth, however, should be placed between the wood and the metal. A door is now made of sheet steel without the wooden core, the stiles and rails only being reinforced with a small amount of cork or similar material.

**364. Counterflashing for Slag Roofs.**—The counterflashing for asphalt or slag roofing should be of tin or copper, which is applied the same as for other roofs.

**365. Canvas Roofing.**—Canvas is sometimes used to cover balcony or porch roofs that are to be used as upper porches. None but the heaviest grade of canvas should be employed for this purpose. When placed on matched sheathing, the canvas should be laid in pine pitch; but if placed over a tin roof, it should be laid in a thick coat of white lead. All seams in the canvas should be double sewed, and if nails are used they should be of copper. After the roof is laid, the canvas should be thoroughly soaked with pure linseed oil, and then given two or three coats of white lead and oil.

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## PLUMBING

**366. General Remarks.**—The plumber is usually required to do all the excavating necessary for water, gas, and sewer connections. His work usually comprises the supplying and placing of the soil and sewer lines with their necessary vents and stacks; the tapping of the corporations gas and water mains and the running of the supplies and branches to the various fixtures and faucets; the setting and connecting of pumps, ranges, filters, or in fact any of the various fixtures and appliances used in connection with the gas, water, or sewer systems.

The nearest point at which sewer, gas, and water mains may be tapped should be ascertained by the architect, and these points should be specified and plainly shown on the drawings. If sewage is to be discharged into a cistern, it should be located on the drawings, with the level of the inlet indicated.

**367. Water Supply.**—If the water supply for a building is to be furnished by a tank located in the attic, the water may be drawn from the city mains direct, or it may be taken from the city mains, if the pressure is insufficient to raise it, a lake, a stream, or some other such source and be raised to the tanks by means of a pump—either hand, hot-air, steam, or electric—or by means of a wind mill or a hydraulic ram.

Water-storage tanks are always used in very high buildings supplied by city mains that have insufficient pressure to force the water supply to the top stories during the day. These tanks are located on the roofs or in the top stories of the buildings, and are filled at night when the water pressure is greater, owing to the fact that less water is being used.

**368. Water Tanks.**—The tanks used for water supply are made of wooden staves, in a manner similar to barrels, or of $1\frac{1}{2}$-inch material built rectangular in shape, and lined with copper, lead, or galvanized iron. Precautions against freezing should be taken, and the tank should be covered and ventilation supplied. A copper or lead

safe with a pipe delivering into a sink in the lower part of the house should be placed underneath the tank. The supply pipe should be taken from the side of the tank and not from the bottom, in order that sediment may not be pulled into the supply system. A draw-off pipe should be taken off the bottom and run into the main gutter or a leader, if possible, but should not be connected directly to the drainage system.

**369. Water Pipes.**—The supply pipes from street mains should be from 1 inch to 6 inches in diameter, the former size being suitable for small residences and the latter for large public buildings. For very high pressures, pressure regulators are placed on the supply pipes just inside of the cellar walls.

The branch pipes to the different fixtures should be of the sizes shown in Table IV. These pipes should be exposed to view and supported by neat hangers on wooden blocks. They should also be tagged where leaving the main, so as to indicate the fixtures that they supply.

TABLE IV

SIZES OF BRANCH PIPES

| Supply Branches to | Low Pressure* Inches | High Pressure* Inch |
|---|---|---|
| Bathtubs | $\frac{3}{4}$–I | $\frac{1}{2}$–$\frac{3}{4}$ |
| Basins | $\frac{1}{2}$ | $\frac{3}{8}$–$\frac{1}{2}$ |
| Water-closet tanks | $\frac{1}{2}$ | $\frac{1}{2}$ |
| Water-closet flushometer | I–I$\frac{1}{4}$ | $\frac{3}{4}$–I |
| Water-closet flush pipe | I$\frac{1}{4}$–I$\frac{1}{2}$ | |
| Sitz, or foot-baths | $\frac{1}{2}$–$\frac{3}{4}$ | $\frac{1}{2}$ |
| Kitchen sinks | $\frac{5}{8}$–$\frac{3}{4}$ | $\frac{1}{2}$–$\frac{5}{8}$ |
| Pantry sinks | $\frac{1}{2}$ | $\frac{3}{8}$–$\frac{1}{2}$ |
| Slop sinks | $\frac{5}{8}$–$\frac{3}{4}$ | $\frac{1}{2}$–$\frac{5}{8}$ |
| Urinals | $\frac{5}{8}$–$\frac{3}{4}$ | $\frac{1}{2}$–$\frac{5}{8}$ |
| Outside hose faucet | $\frac{5}{8}$–$\frac{3}{4}$ | $\frac{5}{8}$–$\frac{3}{4}$ |

**370. Cocks and Valves.**—A **stop-and-waste cock** should be placed on the water-supply pipe just inside of the cellar walls, if city water supply is used direct, and at the base of the stack, if a tank is used. All piping should pitch toward this cock in order that the entire system may be drained at this point.

Each fixture supply branch should have a **valve** between the main and the fixture that will allow the fixture to be cut off for repairs. Such

*High water pressure is any pressure above 40 pounds per square inch; low pressure is anything below 40 pounds.

an arrangement will avoid shutting off the water from the entire building, which would be necessary if no such valves were placed.

**371. Important Considerations in Piping.**—The freezing of water pipes should be carefully guarded against, and, for this reason, as much of the piping as possible should be run in the warm parts of the building. Where exposed, the piping should be protected with hair felt, mineral wool, or some other non-conducting materials.

The friction in a pipe of running water reduces the speed of the flow; consequently, by increasing the sectional area of each branch as it extends from the main to fixtures, the pressure at the faucets is kept more uniform.

Where the water pressure is heavy, the supply pipes should be extended a short distance beyond the faucets. This forms an air cushion that takes up some of the shock due to shutting water off suddenly, thus saving the strain on joints, etc.

**372. Galvanized-iron** and **lead pipes** are used for the water supply. Lead pipe, however, is preferable unless the character of the water is such that it acts as a solvent on the lead. The durability of galvanized iron depends entirely on the thickness of the coating on the interior of the pipe. Where lead pipe is used, it should be supported on shelves or some similar arrangement to prevent sags, which form pockets for sediment, etc. The weights of lead pipe should be the same as given in Table V.

TABLE V

WEIGHT OF LEAD PIPE

| Kind of Pipe | Diameter of Pipe Inches | Weight per Foot Pounds |
|---|---|---|
| AA extra strong . . . . . | 1 | $4\frac{3}{4}$ |
| AA extra strong . . . . . | $1\frac{1}{4}$ | 6 |
| AA extra strong . . . . . | $1\frac{1}{2}$ | $7\frac{1}{2}$ |
| AA extra strong . . . . . | $1\frac{3}{4}$ | 8 |
| AA extra strong . . . . . | 2 | 9 |

The grade of pipe given in Table V is next to the heaviest made, which is designated as extra, extra strong. Five lighter grades are made. The fittings for galvanized-iron pipe should be of malleable galvanized iron, beaded.

**373. Brass pipes** are very durable, and are used in the best work for hot-water pipes or for supply pipes throughout.

**374. Block tin** or **tin-lined lead pipe** make very good pipe: the latter is sometimes used; the former is too expensive for ordinary use.

**375. Filters.**—If the water supply is constantly muddy or contains much foreign matter, filters should be employed, as such sediment is not only dangerous to health and disagreeable, but is also liable to clog waterbacks, boilers, etc. The filters are usually placed in basements on the water-supply pipes.

**376. Circulating Hot-Water System.**—The quick delivery of hot water to bathrooms and lavatories remote from the heater may be accomplished by a circulating system, or loop of pipe, which includes in its circuit the boiler and waterback. A relief pipe of small diameter with an air valve should be placed at the top of the loop, and where necessary to compel the taking of hot water from the loop in the direction of the circulation, check-valves should be placed on the line.

This loop may include a hot-water radiator, which could be used to heat a room over the kitchen or elsewhere.

**377. Safes.**—Safes or pans of sheet copper or lead are frequently placed under plumbing fixtures in bathrooms or lavatories to catch any leakage that may occur and save the ceilings below from damage. These pans are connected by piping to some point over a sink or a tub in the basement, so that any leakage into the pan will at once give warning by the drip below.

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### DRAINAGE

**378. Laying Drain Pipes.**—The plumbing laws of most cities require that the terra-cotta pipe from the main sewer shall not approach the foundation wall nearer than 5 feet. In other words, the pipe from the main sewer to within 5 feet of the building may be of terra cotta, and from this point in it should be of cast iron with branches of cast iron, galvanized iron, or lead. The piping from the end of the cast-iron pipe to the sewer or cesspool is called the *house sewer*. The cast-iron piping from the terra-cotta pipe to the different stacks is called the *house drain*.

A very good job is obtained by laying the drain and sewer pipes on a concrete base, the drain pipe being laid in a brick duct with removable covers of iron at proper intervals for the purpose of inspecting or repairing.

**379. Terra-Cotta Pipe.**—In laying terra-cotta pipe, the cementing of the joints at the bottom of the hub is liable to be imperfectly done, and particles of cement are often left in the pipe. Means

should therefore be taken to remove all such obstructions and to insure a good joint that is uniform throughout its entire circumference. Asphalt makes a good joint in terra-cotta pipe.

The grading of terra-cotta pipe should be done from hub to hub, and not along each individual pipe. This insures obtaining a true and uniform grade.

**380. Cast-Iron Pipe.**—Extra heavy cast-iron pipe should always be used except on small and unimportant work. Cast- or wrought-iron pipe should be free from sand holes, splits, and flaws.

The size, weight, and the maker's name should be cast on each length of cast-iron pipe and fitting, and the average weight per foot for straight pipe should be not less than the following:

$5\frac{1}{2}$ pounds per foot for 2-inch pipe
$9\frac{1}{2}$ pounds per foot for 3-inch pipe
13 pounds per foot for 4-inch pipe
17 pounds per foot for 5-inch pipe
20 pounds per foot for 6-inch pipe
$33\frac{1}{2}$ pounds per foot for 8-inch pipe
45 pounds per foot for 10-inch pipe

**381. Galvanized-iron pipe** is sometimes partly choked with lumps of zinc; such pipe should be rejected, so as to avoid the danger of sediment, etc. lodging in it.

The weight and thickness of galvanized-iron waste, vent, or soil pipe should be as given in Table VI.

TABLE VI

WEIGHT AND THICKNESS OF GALVANIZED-IRON PIPE

| Inside Diameter Inches | Thickness Inch | Weight per Foot Pounds |
|---|---|---|
| $\frac{3}{4}$ | .113 | 1.11 |
| 1 | .134 | 1.66 |
| $1\frac{1}{2}$ | .14 | 2.7 |
| 2 | .15 | 3.6 |
| $2\frac{1}{2}$ | .20 | 5.7 |
| 3 | .21 | 7.5 |
| $3\frac{1}{2}$ | .22 | 9.0 |
| 4 | .23 | 10.7 |

**382. Cutting for Piping.**—All cutting of joists, masonry, etc. necessary for the running of piping should be done by the proper tradesman—not by the plumber. Where piping runs at right angles to the joists, care should be taken to see that the carpenter does no

excessive cutting, also that the cutting is done as close to the bearings as possible, so as not to weaken the joists more than necessary.

**383. Soil Stacks.**—The soil pipe, or stack, is the vertical cast-iron pipe that takes the waste from water closets, basins, tubs, etc. This pipe should be extended at least 2 feet above the roof and kept as far away from dormer windows or other openings as possible. The top should be left open.

**384.** The **main soil stack** should not be less than 4 inches in diameter, as it not only serves as a waste, but also as a vent, pipe. Branch vents and other smaller vent stacks may be connected to this stack above the highest fixture.

The bases of soil stacks should be well supported on brick piers, stone corbels, pipe rests, or by wrought-iron straps suspended from the floor joists. This is often neglected, but is of great importance, as a slight settlement in the stack will open the joints between the branches and the stack. Four-inch cast-iron pipe weighs about 13 pounds per foot, and where a stack is 30 feet or more in height, the weight at the base is considerable.

**385. Drain Pipes.**—The arrangement of drainage and vent pipes should be as direct as possible. The house drain should be run above the cellar floor when possible, and should be supported on pipe rests or piers of brick or stone, or hung from the floor joists. This arrangement makes cleaning and repairing very easy, but it has the disadvantage of taking up considerable room.

Old drains should be thoroughly tested, and, unless found tight, should not be incorporated with new work.

**386. Sizes of Waste Pipes.**—The usual sizes of waste pipes in a plumbing system are as follows:

| | Inches |
|---|---|
| Soil and house drain | 4 to 6 |
| Branches to sinks, tubs, lavatories | $1\frac{1}{2}$ to 2 |
| Slop sinks | 2 to 3 |
| Water closets | 4 |
| Leaders | 4 |

**387. Steam System Waste Connection.**—The condensation from a steam-heating system should not be connected to the house drain, but should be connected just outside of the main trap. The discharge of hot water into the cast-iron house-drain pipe expands the joints, which again contract when a large amount of water of a lower temperature is discharged into the drain or when the steam is cut off. This constant expansion and contraction will finally open up the joints and cause leakage.

**388. Connections.**—The method of making connection between the lead bend and the base of the water closet should be carefully considered, as it is a difficult joint to make.

**389. Location of Stacks.**—All stacks should be made as accessible as possible; they should either be exposed to view or be placed within runways with removable covers or in light or elevator shafts.

**390. Fittings.—Clean-outs** should be placed at proper points on the house drain, so that the branches and main up to the main trap may be cleaned out with wire, etc.

The changes in direction of drains should be made with curved pipes, Y branches, and $\frac{1}{16}$ and $\frac{1}{8}$ bends.

A T or T Y fitting should never be allowed in a drainage system except for the connection of the fresh-air inlet branch to the house drain.

**391. Soil- and Vent-Stack Sizes.**—The size of soil and vent stacks with relation to the number of fixtures should be as given in Table VII.

TABLE VII

SIZE OF SOIL AND VENT STACKS

| Diameter of Soil Stack Inches | Diameter of Vent Stack Inches | Number of Fixtures |
|---|---|---|
| 4 | $2\frac{1}{2}$ | 1 to 15 |
| 5 | 3 | 16 to 30 |
| 6 | 3 | 31 to 50 |
| 7 | 4 | 51 to 80 |
| 8 | 4 | 81 to 120 |
| 9 | $4\frac{1}{2}$ | 121 to 200 |
| 10 | 5 | 201 to 300 |

**392. Traps.**—The **house trap** should be placed in a brick pit, or sump; it should have a removable cover, so that it may be accessible for repairs, etc. This trap should have two clean-out holes.

The **fresh-air inlet** should extend to the outside of the foundation wall from 12 to 16 inches above grade, and should be finished with a return bend.

After "roughing in" is done, all openings of closet bends, vent pipes, etc. should be securely closed, to prevent clogging with sticks, rags, etc.

All traps should have screw clean-outs, so that they may be cleaned from time to time.

**Pot, or grease, traps** are suitable for bathtubs or sinks, where there is likely to be considerable grease, hair, etc. These traps should be made accessible for cleaning.

**Ball traps** should be used where the fixture to which it is connected is not likely to be used for long periods.

The different forms of **running traps** are best for general use.

**393. Location of Traps.**—The trap should be placed as close to the fixture as possible, so that the outlet pipe between the fixture and the trap that is unvented may be as short as possible. This is especially important in the case of urinals.

**394. Size of Vent Branches.**—Vent branches from traps to stacks should be of about the same sizes as the wastes from fixtures. No pipe less than $1\frac{1}{2}$ inches in diameter should be used, and for slop sinks and closets, 2-inch pipe is suitable.

**395. Approval of Plumbing Plans.**—The plumbing laws of the larger cities are complete and exacting, and it is well to make them a part of the plumbing specification by stating that they are to be so considered.

The approval of the board of health or plumbing department of the city in which work is to be done is necessary, and it should be obtained before submitting the drawings and specifications to bidders.

**396. Painting of Piping.**—All exposed water-supply, soil, or vent pipes should be painted with either lead-and-oil or aluminum-bronze paint or both.

**397. Testing.**—When the "roughing in" is completed, the *water* or the *air test* is applied; and after the fixtures are set, the *smoke test* is made.

**398. Fixtures.**—The fixtures are selected and specified from manufacturer's catalogs by the number of the plate and the grade. They include baths and showers, basins, water closets, sinks, laundry tubs, urinals, etc.

**399. Bathtubs** are in two shapes, the French and the Roman, the former being preferable. The enameled iron or painted tub and the solid porcelain tub are the best and are also the cheapest in the end. The showers may be set over the tubs, over separate pans, or over cement floors drained to the sewer.

**400. Wash basins** are round or oval, and are usually set in molded marble slabs. The oval bowl is the better.

**401. Water closets** are made in four types: the plunger, the hopper, the wash-out, and the siphon-jet. The first type should never

be used; the second, only in the very cheapest work; the wash-out closet may be used for good common work; and the siphon-jet should be used in the best work.

Water closets should be placed in rooms with outside windows or proper ventilation.

**402. Sinks.**—There are either kitchen, pantry, or slop sinks. Kitchen sinks are made of solid porcelain, fireclay, iron porcelain-enameled, soapstone, slate, and plain or galvanized cast iron. For good work, the solid porcelain or fireclay sinks are used; for cheaper work, the galvanized-iron or enameled sinks are used.

Pantry sinks are made of solid porcelain, fireclay, enameled iron, copper, and lead. These are all good; the two first-mentioned materials being the best as well as the most expensive. Wooden or rubber mats should be used in the bottoms of pantry sinks to prevent the breakage of fine china or the enamel of the sink.

Slop sinks are made of porcelain, enameled iron, and earthenware.

**403. Laundry tubs** are made of porcelain, earthenware, enameled iron, soapstone, slate, cement, and wood. Wooden tubs should never be used. The other types of tubs are desirable in the order in which they are named.

**404. Urinals** are usually in the form of a trapped bowl or gutter; the former is made of earthenware or iron and the latter generally of iron. The gutter form of urinals is used in public places or buildings.

**405. Faucets.**—The faucets that supply the different fixtures should be specified clearly. In public places where they are likely to be left open, the faucets should be of the self-closing type.

In the best class of work, the exposed metal work of all fixtures is usually nickel-plated; but sometimes the faucets are of plain brass and the traps and piping of lead or iron painted with an oil paint. Explicit statements as to these matters should be made in specifying each fixture.

**406. Flushometers** may be used in place of flushing tanks for water closets, slop sinks, and urinals where the water pressure is sufficient. They should not be used, however, if the pressure is below 10 pounds per square inch.

**407. Plans and Drawings.**—Plans are made of each floor, showing the location of the different fixtures and the drainage and vent pipes. Sections are also made showing the back venting of traps, stacks, etc. These drawings must be approved by the plumbing department of the city in which the work is to be done before the plumber can obtain a permit to do the work.

### GAS

**408. Gas Mains.**—The gas mains should be pitched to a low point near the meter, with a stop-and-waste cock to drain from the system the water of condensation that may accumulate. The pipe should be of standard wrought iron or steel.

**409. Branch Pipes.**—The branches to the outlets should be risers where it is possible, and trapping should be avoided. The outlets should not project less than 1 inch from the face of the plaster and should be securely fastened.

**410. Cutting for Piping.**—All cutting should be done by the carpenter under the direction of the gas-fitter. The pipes should be run as near the ends of the spans of the joists as possible, where cutting is necessary, as cutting at these points weakens the joists less than at the centers of spans.

**411. Fittings.**—The fittings for gas piping should be of malleable galvanized iron. The beaded fittings are preferable to the plain, as they are stronger and present a better appearance.

**412. Testing.**—When completed and capped, the gas-piping system should be tested by forcing compressed air into the piping by means of a hand pump; the pressure of the compressed air should be registered by a pressure gauge or a mercury column. The pressure indicated by the gauge should be from 7 to 10 pounds per square inch, and should be sustained for at least 1 hour. The mercury column should stand at a height of from 15 to 20 inches for a like period. The use of the mercury column is to be preferred, as the gauge is unreliable. In large buildings, it is customary to test the system in sections.

**413. Leaks** are located after the pressure is applied to the system by putting soap suds on the joints of the fittings. The bubbles formed by the escaping air will locate the leaks.

**414. Fixtures.**—Fixtures are made for gas lights alone or for both gas and electric lights. The latter are called *combination fixtures*. These fixtures are usually purchased by the owner or architect and are not included in the specification.

**415. Meters.**—Connections are left at the proper point for the corporation gas meter, which is furnished by the gas company and connected to the main with brass or lead pipe by the gas-fitter. This meter should be supported on a wooden shelf at some accessible point in the basement. A separate meter is sometimes placed on a

branch to the gas stove or heaters. This branch should of course be taken off the main on the outside of the regular meter.

**416. Location of Fixtures.**—The proper heights from the floor for gas brackets or side-wall lights are from 5 feet 6 inches to 6 feet. Pendants should be placed from 6 feet 6 inches to 7 feet from the floor. The positions of the brackets should be carefully considered with regard to the swing of doors, registers, etc. and lights should be placed for sinks and to properly light stairways, closets, etc.

**417. Acetylene gas** is suitable for country houses, and there are a number of companies that make reliable generators. Smaller pipes are used than for coal gas, and also a different type of burner. Copper should not be used in connection with acetylene gas, as the gas forms an explosive compound with it.

**418. Sizes of Gas Pipes.**—The proper sizes of branch pipes for coal and acetylene gas and the allowable number of burners for same is given in Table VIII. In the best practice no pipe smaller than $\frac{1}{2}$ inch is used for coal gas.

TABLE VIII

SIZES OF BRANCH GAS PIPES

| Diameter of Pipe Inches | Maximum Length, in Feet | | Number of Burners | |
|---|---|---|---|---|
| | Coal Gas | Acetylene Gas | Coal Gas | Acetylene Gas |
| $\frac{1}{4}$ | | 20 | | 4 |
| $\frac{3}{8}$ | | 40 | | 7 |
| $\frac{1}{2}$ | 30 | 60 | 4 | 15 |
| $\frac{3}{4}$ | 50 | 100 | 15 | 50 |
| 1 | 70 | 150 | 25 | 80 |
| $1\frac{1}{4}$ | 100 | 250 | 100 | 150 |

**419. Gas Lighters.**—Where there are a large number of lights or the lights are located in inaccessible places, as in churches and theaters, for example, electric gas lighters are employed. The gas is lighted by means of an electric circuit, which includes the gas pipe, an induction coil, and a set of Leclanché cells. The circuit is broken at each jet, and the current in order to pass jumps from the wire to each metal burner, making a spark that ignites the gas.

## HOT-AIR HEATING

**420. Furnaces.**—A great number of furnaces are now on the market, and the architect should thoroughly investigate the different makes and obtain the opinions of persons actually using them before deciding on any particular one.

Table IX gives the relations that should exist between the glass surface, volume of air to be heated, etc., and should be of great assistance in selecting a proper type and size of furnace.

### TABLE IX

FURNACE DATA

| Glass Surface and Equivalent Square Feet | Volume of Air to be Heated per Hour Cubic Feet | Space to be Warmed Cubic Feet | Furnace Heating Surface Square Feet | Grate Area Square Inches | Smoke-Pipe Diameter Inches |
|---|---|---|---|---|---|
| 125 | 10,000 | 2,500 | 53 | 106 | 6 |
| 150 | 12,000 | 3,000 | 62 | 124 | 6 |
| 200 | 16,000 | 4,000 | 85 | 170 | 7 |
| 250 | 20,000 | 5,000 | 106 | 212 | 7 |
| 500 | 40,000 | 10,000 | 212 | 424 | 8 |
| 750 | 60,000 | 15,000 | 320 | 640 | 9 |
| 1,000 | 84,000 | 21,000 | 425 | 850 | 10 |

**421. Hot-Air Pipes.**—The hot-air pipes for the ordinary residence from the furnace to the registers should be proportioned according to the size, exposure, outside glass, and wall area of the rooms they are to supply. The leaders, or pipes, in the cellar should be larger in area than the stacks that they supply and should have a good rise from the furnace to the stacks. The leaders are from 7- to 12-inch round pipe, according to necessity, and the stacks are about $3\frac{1}{2}$ inches by the width necessary. If $2'' \times 6''$ studding is used, the stacks may be widened with good results. The stacks should be covered with asbestos paper, and a great saving in radiation is obtained by also covering the leaders with asbestos paper or felt. Leaders and stacks are usually made of IC or IX bright tin.

**422. Dampers.**—Each leader should be provided with a damper near the place where it joins the furnace, and it should be tagged at this point to indicate the room to which the pipe leads.

**423. Rules for Finding Sizes of Leaders and Stacks.** The following rules will be found valuable in determining the proper sizes for leaders and stacks:

**Rule I.**—*To find the area of the leader pipe required for the first floor, add together the area of the exposed glass surface, in square feet, the area of the exposed wall surface, in square feet, divided by 10, and the volume of the room, in cubic feet, divided by 100; the sum will be the area of the pipe, in square inches.*

**Rule II.**—*To find the area of the leader pipe required for the second floor, proceed the same as in rule I, and multiply the sum found by .8.*

**Rule III.**—*To find the area of the leader pipe required for the third floor, proceed as in rule I, and multiply the sum found by .6.*

For a north or a west exposure, increase the leader-pipe area 10 per cent.

The stacks to the first-floor registers should be of the same size as the leaders. The stacks for the second floor may have .8 of the area of the leader pipe, and stacks for the third floor, .6 or .7. Stacks should have their sectional area increased 10 per cent. for each offset.

**424. Double Stacks.**—Patented double hot-air stacks that save considerable heat and eliminate the use of asbestos covering are now on the market. These stacks consist of an outer and an inner pipe, and are made in 2-foot lengths. A full line of fittings is also supplied.

**425. Registers.**—On account of the grille-work and the shutters, the effective register opening should be calculated at about two-thirds of that given in the manufacturer's catalog. The effective area of the register should equal or exceed slightly the sectional area of the stack. The registers may be specified by number, size, and style from the manufacturer's catalog.

**426. Location of Furnace.**—The furnace should be located toward the north and west sides of the cellar or in the center, and should be handy to the coal bin. If necessary, in order to get sufficient pitch to the leaders, the furnace should be sunk into a pit.

**427. Air Inlet for Furnace.**—The fresh-air inlet should be made of galvanized iron, and should have a valve or damper by which the supply of cold air may be controlled. The opening to the outer air should be on the north or the west side of the building, and should be protected from animals, etc. by a screened sash. The area of the duct should be from two-thirds to three-fourths of the sum of the areas of all the leaders.

**428. Smoke Pipe.**—The smoke-pipe connection should be as short and direct as possible, and the area of the smoke flue should be of the size indicated in Table IX, or larger. If rectangular, a flue of larger area is required than if round.

**429. Heat Circulation.**—The circulation of heat through some branches of a furnace system is often defective and difficult to remedy, but is generally due to reduced suction at the register end of the pipes. This trouble may be remedied by running the ventilating flues from such rooms to a main duct in the attic, through the roof, or into an unused flue in the chimney; or a fireplace or opening into an unused chimney flue will supply the necessary suction. A vent pipe should not be run back to the fresh-air inlet as is sometimes done, as this mixes the foul air taken from the room with the fresh supply.

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### STEAM AND HOT WATER

**430. Boilers.**—Steam and hot-water boilers are made in many varieties. The best types are made in sections, the number of which determines the boiler capacity. Boiler catalogs usually give for each boiler the number of sections, the length and the height, the size of the grate, the capacity of the fire-pot, the size of the steam and return-main outlets, and the amount of radiation that it is figured to supply.

The selection of a type of boiler should be made with great care. If possible, different makes of good reputation in actual use should be looked over and their efficiency thoroughly investigated.

Boilers are made to burn anthracite, bituminous coal, or coke.

**431. Boiler Capacity.**—The radiation capacity of boilers varies from about 225 to 6,000 square feet, the ordinary residence requiring from 300 to 600 square feet.

**432. Boiler Setting.**—The boiler should be set on a concrete foundation, and the outer surface of it should be covered with an asbestos cement to the thickness of 1 inch. This cement is applied in three coats while the heater is under fire. The final coat should be rubbed smooth with a piece of wet rubber, after which the entire surface is covered with 6-ounce canvas put on with good flour paste.

**433. Central-Station Steam Supply.**—When steam is supplied from an outside or central station, as is done in many cities and towns, or where the boilers are in separate buildings, as in public institutions, the steam is delivered by an underground main through the cellar wall. This service pipe is supplied with a shut-off valve, a pressure-reducing valve, and a pressure gauge. As a rule, the water of condensation is delivered into the sewer; but before this is done it should be cooled, after passing through a steam trap, by running it through a cooling coil of proper size. This cooling coil is usually a coil of indirect radiation.

In public institutions where the central station is near by or at a lower level, the water of condensation may be either pumped to the

central station or allowed to flow back to the boilers and used over again.

**434. Exhaust and Vacuum Steam Systems.**—The exhaust and vacuum steam systems are used considerably, and their circulation of steam at a low pressure is accelerated by a pump or other means at the end of the return main. As exhaust steam or steam at a very low pressure may be used, these systems are economical if properly installed.

**435. Cutting for Steam Fitting.**—The carpenter and the mason should do all necessary cutting for the steam fitter, and a clause to this effect should be in both the heating and the general specifications.

**436. Piping.**—The pipes of a steam system should be run in such a manner that the supply of steam will be evenly distributed to all parts of the building. When the piping is completed and tested, the distribution of steam should be carefully noted, and if it is necessary to run an extra feeder to any point, it should be done. This extra piping should be provided for in the specification. Care should be taken to have piping large enough and properly pitched.

**437. Drip Pipes.**—Where water is liable to accumulate in the steam mains, drip pipes should be taken off and connected to the return. This will relieve the system of water that would otherwise interfere with the circulation of the steam. These drips should be taken off the bottom of the main.

**438. Future Extensions.**—Where additions to the system may be required at some future time, the piping should be proportioned accordingly, and plugged T's placed where the future branches may be needed.

**439. Supply Pipes.**—The supply pipes to the hot-water radiators on the upper floors, where a two-pipe system is used throughout, may be smaller than the pipes for the same-sized radiators on the first, or lower, floor; because the higher the radiator, the greater will be the pulling force of the return circulation.

**440. Risers.**—The supply risers to the different radiators, both for steam and hot water, should be taken from the top of the main. The returns of the hot-water radiators should connect into the side or the bottom of the main, while the steam returns should connect into the top.

**441. Branches.**—Branches leaving the steam main at an angle should have a pitch of 45°, and should be of one size larger pipe than the riser, using reducing fittings for connections.

**442. Pipe Covering.**—Where a boiler is used, the steam main and returns should be covered with sectional covering. This covering reduces the amount of condensation and keeps the temperature of the water in the returns higher than would be the case without the covering. Where the condensation is drained to a sewer, it is not necessary that the return lines should be covered.

**443. Pipe Defects.**—It is important that the full area of the pipes be obtained, and for this reason all pipe should be cleared of burrs, dirt, scale, etc.

**444. Supports.**—Expansion and contraction of hot-water and steam-pipe lines should be provided for by using proper expansion hangers and supports for both the piping and the radiators.

**445. Protecting Piping and Woodwork.**—Ceiling and floor plates should be placed about the piping where it passes through floors and ceilings; and where the piping passes through wooden walls, metal sleeves with ample clearance should also be used, in order to protect the woodwork and to facilitate the removal of the piping for repairs, etc.

All steam and hot-water pipes should be painted or bronzed where exposed; but where possible, these pipes should be hidden from view

**446. Fittings.**—Long-turn fittings should be used in hot-water systems, as they greatly aid the circulation.

**447. Unions.**—The common screw union should never be used in hot-water piping; the right-and-left coupling should always be employed instead. The flanged unions should be employed for large pipes.

**448. Valves.—Gate valves** should be used in a hot-water system, as they offer less resistance to the circulation than a globe valve. Valves larger than $2\frac{1}{2}$ inches should be iron-bodied and brass-mounted; smaller valves may be brass throughout.

Gate valves should be placed on branch mains and returns, so as to control each radiator or group of radiators separately. This arrangement allows repairs to be made on the radiators or radiator valves without turning off the steam from the entire building. These gate valves should be labeled, so as to indicate the radiators they control.

**Stop-valves** should never be placed on the line between the boiler and the expansion tank of a hot-water system; the tank should also be protected from freezing.

To prevent the freezing of water in radiators when the valve is closed, a common practice is to have a small hole drilled through the valve so that a small circulation of water may be maintained at all times.

**449. Vents.**—Air vents should be placed on the return lines in the two-pipe steam system, so as to get rid of any air that may accumulate. Vents should also be placed on the hot-water system at the proper points.

**450. Radiator Connections.**—Hot-water radiators cannot be successfully operated with a single connection; they should have two connections, one for the inlet and the other for the outlet. The supply pipe may enter the top or bottom of the radiator, but the outlet should always connect at the bottom.

**451. Repairing Leaks.**—As soon as the work of installing a heating system is completed, steam or water, as the case may be, should be turned into it, and if any leaks are discovered, they should be repaired immediately. The contractor should be required by the specifications to agree to make repairs free of charge for one winter following the completion of same, where such repairs are necessitated by defective workmanship or material.

**452. Temporary heat** for drying plaster, etc. is often necessary before the building is completed, and the specifications should state plainly whether it is to be furnished by the contractor or by the owner.

**453. Radiation.**—In buildings heated by steam or hot-water systems, the term *radiation* is used to designate the surfaces used for heating purposes, and these may be either *direct*, *indirect*, or *direct-indirect*. The amount of radiation is usually governed by the number of sections, or coils, in the radiators, which are made in a great many styles and in several forms for special use.

Each radiator should be supplied with a nickel-plated air valve that will allow the air to escape, but will close when the steam reaches it. The valves controlling the supply and return pipes should have wooden or hard-rubber handles to protect the hands from the heat.

In bathrooms, narrow hallways where space is valuable, or basements where the radiators must be high enough to give flow for the condensation back to the boiler, wall radiators should be used.

Dining-room radiators have a cupboard in the center, with sections on either side. This cupboard is intended to be used for keeping dishes and food warm.

As a rule, radiators should be placed on outside walls, under or near exposed windows, where they will warm the cold air that may enter through the cracks.

The ordinary type of radiator can generally be used for both water and steam, but as this is not always the case, careful investigation should be made before specifying any particular kind.

The specifications should give a list of the different radiators, with the amount of heating surface and the height in each case. It should also state the style and the number of sections.

**454. Direct Radiation.**—In direct radiation, the air in a room is heated by a radiator placed in the room. The different forms of direct radiation may be classed as ordinary, window, wall, corner, dining-room, and built-up pipe or coil radiation.

**455. Indirect Radiation.**—The radiators for indirect radiation are usually placed in the basement, and are encased in galvanized-iron boxes, which are connected to the outside atmosphere and to the registers by ducts also made of galvanized iron. By this arrangement, the rooms are supplied with heated fresh air. Indirect radiation is more expensive than direct radiation, but is considered more healthful.

Where indirect radiation is employed, about 50 per cent. more radiation surface is required than would be needed for the same number of rooms heated with direct radiation. This is due to the loss of heat from the ducts during transmission from the galvanized-iron radiator boxes to the registers, as fresh air is constantly being delivered from the outside, while in the direct method the radiator simply heats the air of the room.

Indirect radiation alone or in combination with direct radiation may be used throughout a building; for example, direct radiation is frequently used on the second floor and indirect throughout the first floor, or the indirect may be used only for the best rooms on the first floor, the balance being direct. Indirect on the first floor and direct on floors above makes a very satisfactory arrangement.

As many indirect stacks as possible should be placed on the north side of the building. The radiators should be supported by an iron pipe suspended from the ceiling by iron rods.

**456. Direct-Indirect Radiation.**—The radiator used for direct-indirect radiation is placed in a manner similar to those used in direct radiation, but has a specially constructed base, which is enclosed and connected by a small duct to a register in the outside of the wall. It also has a register in the base, which opens into the room. When the inner register is closed, the outer one is open, allowing fresh air to enter and pass up between the sections of the radiator, thus making it an indirect type of radiator. When the inner valve is open the outer one is closed, and the radiator becomes direct.

About 25 per cent. more radiating surface is required for direct-indirect radiation than for direct radiation, where it is used as indirect.

**457. Vacuum System.**—About 25 per cent. more radiating surface is required for a hot-water or a vacuum direct system than

would be necessary for an ordinary direct steam installation to do the same amount of work.

**458. Plate-warming cupboards** are often placed in the butler's pantry or elsewhere, and are a great convenience to the housewife. They consist of a cupboard lined with tin, copper, or galvanized iron, and have shelves made of coils on which perforated sheets of galvanized iron are placed.

**459. Thermostats.**—A thermostat is an electric device used to regulate the boilers—and thus the temperature—of a heating system, by opening or closing the valves or doors that control the draft under the fire or between the fire and the chimney. The thermostat depends on the breaking or making of an electric current through the rising and falling of a mercury column or the expansion and contraction of strips of some suitable substance. Instead of controlling the proper flues of a boiler or furnace, the thermostat may control a mechanism that will open or close a valve in the main, where steam is supplied by a central station or from a main in the street.

## VENTILATION

**460. Ventilating Systems.**—The ventilation of the ordinary residence is sufficiently taken care of by fireplaces and cracks at doors and windows, but for schoolhouses, asylums, and buildings where many persons are in the rooms and the consumption of oxygen is large, some method of artificial ventilation is needed. The usual methods may be classed under the *vacuum* and the *plenum systems* or combinations of these two.

**461. Vacuum System.**—In the vacuum method the air is exhausted from the different rooms by means of a fan or heated air column, thus causing a suction and making room for the entering heated air.

**462. Plenum System.**—The plenum method is usually combined with the heating system, the air being forced over heating coils and into ducts leading to the various rooms, thus displacing the foul air, which is either drawn out by a fan, a heated air column, or by the natural rising of the hot air, as in theaters and lecture halls where the air escapes at the center of the ceiling. In theaters, the rise of the air is often assisted by a group of lights in the central chandelier.

**463. Amount of Air Needed.**—Table X gives the amount of fresh heated air considered necessary for each occupant per hour in different classes of buildings.

TABLE X

AMOUNT OF FRESH AIR REQUIRED IN DIFFERENT BUILDINGS PER OCCUPANT

| Class of Building | Cubic Feet per Hour per Occupant | Cubic Feet per Minute per Occupant |
|---|---|---|
| Hospitals | 4,000 to 8,000 | 66 to 100 |
| Court rooms | 2,000 | 33 |
| Legislative halls | 2,000 | 33 |
| Theaters | 1,500 to 1,800 | 25 to 30 |
| Halls | 1,000 to 1,200 | 17 to 20 |
| Churches | 1,000 to 1,200 | 17 to 20 |
| Schools | 1,800 to 2,400 | 30 to 40 |

**464. Vents.**—Vent registers at the floor should be low and wide. If ceiling vents are used, they should never be placed directly over the hot-air register, as it will cause the hot air to short-circuit and thus leave the balance of the room unsupplied. In this case, the vent and hot-air registers should be on opposite sides of the room. Placing vent registers at both the floor and the ceiling of a room and on the side opposite the hot-air registers is a good arrangement, as it gives ventilation to both the upper and the lower parts of the room.

**465. Schoolhouse Ventilation.**—Schoolhouses heated by an indirect plenum system should have a certain amount of direct radiation to take care of the rooms when the fan is stopped; but, if possible, the ventilation should be so arranged that when the fan is not in use, suction will be furnished by natural ventilation to make the rooms reasonably warm without the use of the direct radiation.

Schoolrooms should contain from 126 to 150 cubic feet of air space for each scholar, the ceilings being from 12 to 13 feet high.

**466. Ventilation and Heating Plans.**—Plans of each floor and basement should be made that show the location of the radiators, direct and indirect, and the registers; the direction and sizes of the steam or hot-water piping and the galvanized-iron ducts; and the position of the fans, heaters, etc. These plans should supplement the specifications.

## ELECTRIC WIRING

**467. The Ampere.**—The *ampere* is the practical unit of electric current, or flow of electricity. The flow of electric current in amperes is analagous to the flow of water in a pipe in gallons per second.

**468. The Volt.**—The *volt* is the practical unit of pressure, or *electromotive force* (abbreviated *E. M. F.*), or difference of electric potential, which causes current to flow. Electromotive force, or difference of electric potential, is analagous to head in liquids. Electromotive force in volts may be compared to the head of a liquid, in feet.

**469. The Ohm.**—The *ohm* is the practical unit of resistance to the flow of current, and is analagous to the resistance of the inner surface of a pipe to the flow of water.

**470. The Watt.**—The *watt* is the practical unit of electric power. It is the product of 1 volt and 1 ampere and is sometimes called the **volt ampere.** It is equal to $\frac{1}{746}$ of a horsepower, so that 1 horsepower = 746 watts.

**471. High and Low Potential.**—A *low-potential system* is one on which the electromotive force is over 10 volts and less than 550 volts. A *high-potential system* is one on which the electromotive force is between 550 and 3,500 volts. An *extra-high-potential system* is one on which the electromotive force is over 3,500 volts. High-potential wires are seldom brought into buildings, and extra-high-potential wires never, except into power stations and substations.

**472. Ohm's law** expresses the arithmetical relation between the ampere, volt, and ohm, as follows:

$$\text{amperes} = \frac{\text{volts}}{\text{ohms}};$$

or, the rate of flow of the current is equal to the electromotive force divided by the resistance.

**473. Quantity of Currents.**—The quantity of electric current, or the number of amperes, used in a circuit depends on the number and size of lamps, fans, etc. supplied, on the efficiency of these various appliances, and on the electromotive force that causes the current to flow.

**474. Laying Out Systems.**—The laying out of a system should be so made that neither the cost of electric energy nor the cost of the wiring shall be excessive.

**475. Candlepower for Lights.**—Table XI gives the approximate number of amperes of current required for different candlepower incandescent lamps with currents of 110 volts or 55 volts.

TABLE XI

CURRENT REQUIRED FOR ELECTRIC LIGHTS

| Lamp Candlepower | 110-Volt Current Amperes | 55-Volt Current Amperes |
|---|---|---|
| 16 | .5 | 1 |
| 32 | 1.0 | 2 |
| 50 | 1.5 | 3 |
| 100 | 3.0 | 6 |

**476. Wire.**—Copper wire is used almost exclusively for electric conductors, because it has low resistance and is easily soldered when splicing. Small wires are made solid; large wires and cables are made of a number of strands of finer wire twisted together.

**477. Wire Sizes.**—The size of wires required depends on the quantity of current to be carried, the length of the wire, and the voltage at which the current is supplied. The proper size may be calculated or obtained from tables prepared for this purpose.

All wire larger than No. 10 Brown & Sharpe gauge should be stranded, as it would be too stiff as a single wire to handle easily. No wire smaller than No. 14 Brown & Sharpe should be used except in flexible cord and fixtures, on account of its resistance and liability to breakage.

**478. Wire Cables.**—For large buildings where a heavy circuit is required, a lead-covered service cable is used. This cable is run underground in an iron pipe from the building to the company's pole, which it ascends to the main cables.

**479. Wire Resistance.**—The amount of resistance of a wire varies directly as its length and inversely as its size; the larger the wire the less the resistance.

**480. Making Joints in Wiring.**—In making joints in electric conductors, the insulating covering on the portion of the wires to be joined should be cut away and the wires scraped clean. They should then be twisted together until the joint is mechanically and electrically secure, after which it should be well soldered to preserve the connection and then covered with insulating tape.

**481. Methods of Wiring.**—For the cheaper class of buildings, concealed knob-and-tube or porcelain cleat work is sufficiently good; but for the better grade of work, conduits should be used. For the wiring of an old building, wooden molding or conduit can be placed directly on the plaster or woodwork and afterwards painted. Hard woods should be used for molded work.

**482. Knob-and-tube work** should have wires of opposite polarity not less than 10 inches apart. The outlets should be formed with American circular loom or porcelain bushings thoroughly fastened in place. Knob-and-tube work may be used for either high- or low-tension current, but conduits should only be used for a low-tension current. Where high-tension current is used, the wiring should be in plain sight and never encased unless specially ordered by the building department.

**483. Conduits.**—Conduits for wires are not entirely for the protection of the wires, but are intended also as a raceway through which the wires may be drawn. The conduit is fastened in place by hooks and straps in a manner similar to gas piping.

**484. Armored Conduits.**—The flexible-steel armored conduit consists of a spiral of metal strips presenting convex surfaces inside and out. This is a very strong and flexible conduit. The ordinary conduit is called iron-armored insulating conduit, and is supplied with elbows, couplings, and other fittings. The former is not waterproof and should be used only where it will not be exposed to moisture.

Neither of these conduits should be used in sizes smaller than $\frac{1}{2}$ inch inside diameter. Two and three wires can be run in the same conduit so that the main feeders and branches may each have their single conduits.

**485. Conduit Elbows.**—The changes in direction of conduit work are made with bent conduits or by standard elbows. There should not be more than four elbows in any one run from the cut-out box to the switch or the cut-out box to the outlets, in order that the *fishing* (pulling the wire through the conduit) may be easily done.

**486. Pull Boxes.**—Long lines of conduit should have what are called *pull boxes* inserted at such points as will assist in the fishing process.

**487. Electric Connection.**—A ground connection should be permanently made with the conduit, as it is difficult to prevent its partial grounding in any case. All parts of a conduit system should form one electric unit; that is, electric connection between conduit ends at junction boxes or cabinets should not be broken.

**488. Outlet boxes** for conduit work are of two types, one where the box is made for a given position with a given number of outlets, and the other where the position and number of outlets are variable. In the latter type, the sides are made with circular indentations, which may be knocked out with a hammer to make an outlet at the desired point.

**489. Finishing Conduit Work.**—After the conduit is all in, the plastering may be done before the wires are fished, after which tests should be made to see that there are no grounds and that the insulation resistance is sufficiently high.

In conduit work, when wires have been fished, the openings about the wires should be plugged at outlets and made as moisture-tight as possible with tar paint or some other suitable compound.

**490. Location of Wires and Conduits.**—The wires and conduits in wooden buildings are run between the joists and studding; on brick or stone walls, in chases or behind furring; and in fireproof construction, between floor arches and suspended ceilings, in chases of partitions, behind casings of columns, in shafts, and in wooden moldings upon the surface of the plaster. In fireproof buildings, the main feeders are usually run in a shaft from which the branches are taken through cut-out cabinets at each floor.

**491. Electric Meters.**—The meter or meters for large buildings are usually placed on a panel in a separate closet or room, where they will be accessible to no one except the janitor or other authorized person. Every precaution should be taken to avoid fire resulting from melting fuses.

For residences of ordinary size, the meter and main switch are usually placed in the attic, and are enclosed in a panel box fitted with a door, which should be kept locked.

Electric-light companies usually furnish and erect their meters on panel boards provided for that purpose.

**492. Transformers** are usually placed on the poles at the end of the lead service cable from the building, and serve to transform the high-potential current of the mains, or pole line, to a low-potential current suitable for use in the building.

**493. Specifying Wiring.**—In specifying the drop in voltage, it is better to state the permissible drop in volts instead of in per cent.; that is, when the voltage to be supplied is known. For example, if the current is brought into the building at 115 volts, specifications often limit the drop in feeders to 3 volts, and in distributing circuits to lamps to 2 volts, or a total of 5 volts, making the lamp voltage about 110.

The specification should state whether the wiring shall be on the three- or the two-wire system.

**494. Feeders** are run from the main switch to the various distributing cut-out cabinets from which the distribution circuits are run, to the lamps, etc. The feeders and the branches are all fused, so that if the current is raised above the safe carrying capacity of the branch, the fuses are melted, thus breaking the circuit. These fuses are called *cut-outs*. Cartridge fuses are the best.

**495. Cut-Out Cabinets.**—The distributing centers just mentioned are called **cut-out cabinets,** and are required by the Underwriters' rules to be lined with marble, slate, or asbestos board, and otherwise made safe from fire. These cabinets are usually sunk into the wall, and are trimmed in a manner similar to the doors and windows. The doors should be glazed and fitted with locks, and all the woodwork used should be as dry as possible. The switches of the different circuits should be tagged, indicating the circuits they control.

**496. Capacity of Branch Circuits.**—Branch circuits depending on one cut-out should not carry more than 660 watts, the power required for twelve ordinary 16-candlepower lamps. A violation of this rule may render a building uninsurable.

**497. Switches.**—The switches that control the lights in a room are often grouped in one box with a plate to cover them all. The face plates should match the other hardware of the room.

**498. Receptacles.**—Where temporary current may be required for reading lamps, fans, etc., receptacles, or connecting plugs, are placed in the floor or the side wall. Connection to the fixtures from these receptacles is made by means of flexible cord.

**499. Specifying Switches and Receptacles.**—A list of the different switches and wall receptacles with their positions and the lights they control should be included in the specification, and three-way switches should be used where a group of lights are to be controlled by two switches at different points. The particular make of switch to be used should also be specified. The flush-type switch is the neatest.

**500. Methods of Fastening Fixtures.**—Suitable means of support should be provided for the fixtures. If combination fixtures are used, the gas outlets when properly fastened will do; but, if the work is straight electric conduit work, a threaded stud fastened to the bottom of the outlet box should be used. Wrought-iron threaded T's fastened to cleats are used for knob-and-tube work and molded work.

**501. Rules for Wiring.**—The rules laid down by the National Board of Fire Underwriters in their National Electrical Code are now followed by all the best electrical contractors, and the rules have been approved by The American Institute of Architects, The American Institute of Electrical Engineers, The American Society of Mechanical Engineers, The National Board of Fire Underwriters, and similar organizations. These rules should be made a part of all electrical specifications.

**502. Approval of Wiring.**—A certificate of approval may be obtained by the electrical contractor by having the authorized inspector of the Board of Underwriters look over the work. The contractor should be required by the specifications to obtain such a certificate of approval and to deliver the same to the owner on completion of the work, the acceptance of which should be made conditional on the delivery of this certificate.

**503. Electric Appliances.**—Various electric appliances are at the disposal of the architect, among them being bells or buzzers, clocks, controlled by a master clock, door openers, burglar alarms, gas lighters, pumps, fans, storage batteries, temperature regulators, or thermostats, and watchmen registers.

Drawings are usually made showing the location of fixtures, switches, cut-out boxes, meters, and main switches, and are supplementary to the specifications.

# ESTIMATING AND CALCULATING QUANTITIES

(PART 1)

## INTRODUCTION

**1. Scope of Subject.**—The art of estimating is very important both to the architect and to the builder; to the latter, in that he must employ some systematic method of estimating in order to carry on his business successfully, and to the former for the reason that he should at all times be able to estimate the cost of the buildings that he designs.

The science—for such it is—of fixing prices on a piece of work in any branch of the building trades must be based on an extended experience. With a little practice, any one can learn to take off the quantities of materials, but when it comes to determining the rates, only persons having extensive and varied knowledge of building and costs of various details can accurately estimate the time and labor required to complete the work. In order, then, that the duties and requirements of a practical estimator may be thoroughly understood, a number of detailed estimates will be given in this Section as guides. It should be remembered, however, that as the prices of materials and labor vary from those assumed, so will the estimates vary. The information given in detail should be considered only as a general guide in analyzing the elements that enter into the constructive problems in each department of the building trades. In

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this way it will be possible to determine intelligently the various unit costs. The estimates given are, in general, net figures, and do not include any contractor's profit.

**2. Qualifications of the Estimator.**—In the United States, there are no standard or definite rules on estimating that hold good in every section. The builders of each locality have their own ideas and customs regarding the subject. This fact, together with the difference in the cost of labor in various parts of the country and the fluctuations in the market price of materials, requires, as before remarked, that a competent estimator be a man of long and varied experience in the business. There are, however, certain practical rules and suggestions that will materially assist in taking off the quantities and in valuing the labor required for any building operation. These points will therefore be taken up and considered in detail in this Section.

**3. Important Factors.**—The prime considerations in making an estimate are accuracy and time. To these ends the estimator must systematize his efforts, and endeavor to do a maximum amount of work in a minimum amount of time. This, however, should not be done at the expense of accuracy, for accuracy is the most important factor and is only insured when the figures are carefully checked. The estimator, therefore, while avoiding too great refinements in calculation, should aim at correctness rather than at speed in doing the work. Very frequently do the effects of haste and inaccuracy in estimating the cost of a structure become evident when it is too late to remedy the errors, resulting sometimes in the financial ruin of the builder that trusts too implicitly in the estimator's figures.

A record should be kept of all estimates made, as this kind of information is most valuable and establishes a precedent on which to base subsequent estimates, as well as a check on the work at hand.

# PRINCIPLES OF ESTIMATING

## APPROXIMATE ESTIMATING

**4.** In order to make a preliminary estimate, before the plans of a structure are drawn, but after the general dimensions of the proposed building have been determined, architects and builders sometimes employ a method of **approximate estimating,** by which the cost is figured at

TABLE I

COST OF BUILDINGS PER CUBIC FOOT

| Class of Building | Cost Cents per Cubic Foot |
|---|---|
| Small frame buildings, costing from $800 to $1,500 | 10 to 12 |
| Frame houses, 8 to 12 rooms, costing from $1,500 to $10,000 | 12 to 15 |
| Reinforced-concrete mill buildings | 10 to 14 |
| Brick houses, 8 to 10 rooms | 15 to 18 |
| Highly finished city dwellings, brick or stone | 20 to 25 |
| Schoolhouses, brick | 12 to 20 |
| Churches, stone | 20 to 40 |
| Office buildings, well finished | 35 to 50 |
| Hospitals, libraries, and hotels | 35 to 50 |

so much per cubic foot of the building, the rate varying according to its character and the finish required. The method is also considerably used by insurance companies in fixing the amount to be placed on a building. It should be borne in mind that this method gives the approximate cost

only, and should never be used in figuring the contract price of a building. This estimate, however, may be used to advantage in checking the accurate estimate, with which it will frequently be found to agree remarkably well.

Table I shows the approximate cost per cubic foot of various kinds of structures. In computing the contents of a building, there is no uniformity in practice, but no great error will be made in figuring the solid contents from floor of cellar to ridge of roof.

## OUTLINE OF THE WORK

**5.** The drawings and specifications of a structure are the guides that the estimator must follow in making his computations. All measurements necessary for calculating the quantity of the materials required are obtained from the drawings; and all information in regard to the character of the workmanship and the quality of the materials to be used is furnished by the specifications.

In compiling a schedule, there are three stages to the operation: (1) Taking the dimensions for each of the various classes of work; (2) computing and collecting the quantities; and (3) estimating the cost.

In carrying out the first of these steps, each of its subdivisions should be considered in the order in which the work will be executed in the building. This order is about as follows:

1. Excavation
2. Concrete work
3. Stonework
4. Brickwork
5. Carpentry
6. Roofing
7. Plastering
8. Joinery
9. Hardware and ironwork
10. Heating and ventilation
11. Plumbing and gas-fitting
12. Painting and papering
13. Glazing

The third step, estimating the cost, may be subdivided into cost of labor and cost of material. The latter can be definitely fixed by an examination of lists giving current prices of materials; while the former must be based on a

fixed rate of wages per day for the various classes of workmen.

The second and third branches of the work, being closely connected with the first, will be partly considered in connection with it, and, later, in detail in the complete example on estimating.

## ACCURATE ESTIMATING SCHEDULE

**6.** There are so many items to be considered in a careful estimate, that the estimator should have a list of those coming under each of the main headings already given, and in compiling a schedule he should follow this order. The following list, which is arranged to assist in making an estimate on a dwelling house, will serve as an example of the general method that should be adopted:

### EXCAVATION

Cellar
Areas
Piers
Privy vaults
Footings
Cesspool
Catch basins
Wells
Pipe trenches
Fence trenches
Grading
Filling
Labor

### CONCRETE WORK

Cement
Sand
Broken stone
Form lumber
Foundation walls
Partition walls
Piers
Exterior walls
Concrete blocks
Concrete cornices
Core walls
Backing
Cesspools
Tanks
Wells
Area walls
Chimneys
Footings
Floors
Columns
Pavements
Fences
Hearths
Steel reinforcement
Anchor bolts
Nails and spikes
Labor

### STONEWORK

Lime
Cement
Sand
Mortar
Foundation walls
Exterior walls
Partition walls
Piers
Area walls
Cesspools
Wells
Chimneys
Footings
Cut or dressed stonework
Carved stonework
Pavements
Stone fences
Stone hearths
Anchors and bolts
Labor

### BRICKWORK

Lime
Cement
Sand
Mortar
Foundation walls
Exterior walls
Partition walls
Piers
Area walls
Terra-cotta work
Tiling
Cesspools
Wells
Range setting
Furnace setting
Footings
Chimneys
Trimmer arches
Brick hearths
Pavements
Fences
Labor

### CARPENTRY

#### Framing

Girders in cellar
Sills
Cross-sills
Posts
Beams
Girts
Studs
Plates
Deck plates
Tower plates
Braces
Joists, basement
Joists, first story
Joists, second story
Joists, third story
Joists, attic story
Ceiling beams
Headers
Trimmers
Common rafters
Hip rafters
Valley rafters
Purlins
Furring

FRAMING—*Continued*

Ridge pole
Collar beams
Lintels
Framing piers
Outlookers
Carrying beams
Ironwork
Rods and bolts
Nails and spikes
Labor

COVERING

Sheathing lumber
Sheathing paper
Base
Siding
Shingles
Flooring
Corner boards
Casings
Cornice
Labor

ROOFING

Tin
Shingle
Slate
Tile
Paper or felt
Hanging gutters
Conductor pipes
Conductor heads
Flashings
Gutter linings
Solder
Cresting
Finials
Conductor hooks and fastenings, nails and hooks
Cast shoes or boots
Labor

PLASTERING

Lath
Lime
Sand
Hair
Plaster of Paris
Plastering mortar
Deafening
Back plastering
One-coat work
Two-coat work
Three-coat work
Plaster board
Patent plaster
Tiling, marble, etc.
Stucco cornices
Stucco arches
Stucco centers
Nails
Labor

JOINERY

INSIDE AND OUTSIDE FINISH

Window frames
Door frames
Sashes
Doors
Base
Architraves

INSIDE AND OUTSIDE FINISH—*Continued*

Corner and plinth blocks
Outside and inside blinds
Brackets
Wainscoting
Moldings
Planed lumber
Posts
Columns
Balusters
Hand railing
Nails and screws
Labor

STAIRS

Rough lumber
Treads and risers
Strings
Spandrels
Moldings
Newels
Hand railing
Balusters
Brackets
Bolts
Nails and screws
Labor

HARDWARE

Mortise locks
Rim locks
Padlocks
Butts (various sizes)
Wrought butts
Strap hinges
Blind hinges
Sash fasteners
Sash weights
Shutter bars
Sash lifts
Sash cord
Transom lifters
Cupboard catches
Hooks and eyes
Drawer pulls
Mortise bolts
Door stops
Door hangers
Axle pulleys

HEATING AND VENTILATING SYSTEM

HOT-AIR HEATING

Furnace
Cold-air ducts and slide dampers
Hot-air pipes, elbows, and dampers
Register boxes
Registers
Sheet-tin and asbestos fire protection
Smoke pipe
Labor

STEAM HEATING

Boiler
Regulating and safety appliances
Smoke pipe
Steam pipes
Return pipes

STEAM HEATING—*Continued*

Fittings
Hangers
Indirect, direct-indirect, and direct radiators
Valves
Air vents
Floor and ceiling plates
Galvanized sheet-iron casings for indirect stacks
Sheet-iron indirect flues, screens, and dampers
Indirect registers and boxes
Japanning and bronzing
Pipe coverings
Labor

HOT-WATER HEATING

Heater
Automatic damper regulator
Smoke pipe
Expansion tanks
Radiators, pipes, fittings, etc., same as for steam heating
Labor

## PLUMBING AND GAS-FITTING

PLUMBING FIXTURES

Kitchen range with water-back
Plunge baths
Shower baths
Foot baths
Sitz baths
Wash basins
Water closets
Urinals
Kitchen sinks
Pantry sinks
Slop sinks
Laundry tubs
Safes
Hot- and cold-water faucets for fixtures
Labor

WATER SUPPLY

*City Supply*

Permits
Corporation connections
Excavation
Extra-heavy lead, iron or brass service pipe
Curb cock and box
Stop and waste

*Well Supply*

Storage cisterns
Cistern filters
Pumps
Supply tanks
Outside piping
Lawn and garden hydrants
Fittings, etc.
Wrought-iron pipe fittings
Brass pipe fittings
Lead pipe fittings
Solder nipples
Stop-cocks
Pipe straps

WATER SUPPLY—*Continued*

Metal tacks
Kitchen boiler and stand
Wiping solder
Labor

HOUSE DRAINAGE

Permits
Sewer connections
Excavations
Vitrified sewer pipe and fittings
Earthenware traps
Portland cement
Unglazed drain pipe
Cast-iron soil pipe and fittings
Lead and oakum
Cast-iron traps
Handholes and clean-outs
Lead bends, brass ferrules
Lead soil, waste, and vent pipes
Lead traps
Brass traps
Fixture connections (brass)
Wrought-iron, galvanized, or asphalt-coated drain, soil, and vent pipes and fittings
Fresh-air inlets, vent caps
Vent-pipe flashings
Wall hooks, straps, bands, and hangers
Wiping solder
Labor

GAS-FITTING

Permit
Tapping main
Excavation
Meters
Stop-cocks
Drip cups
Piping
Straps and hangers
Fittings
Pressure regulators
Chandeliers
Pendants
Wall brackets
Pillar lights
Globes, shades, and fireguards
Gas stoves and ranges
Gas-heater connections
Labor

## PAINTING AND PAPERING

PAINTING

Body of house
Trimmings
Blinds
Roof
Porches
Inside work
Floors
Ceilings
Walls
Sash
Shelving
Mantels

PAINTING—*Continued*

| | |
|---|---|
| Oiling | Fences |
| Polishing | Outbuildings |
| Varnishing | Labor |

PAPERING

| | |
|---|---|
| Paper | Lining paper |
| Borders | Labor |

GLAZING

| | |
|---|---|
| Sheet glass (single or double thick) | Ribbed glass |
| | Frosted glass |
| Plate glass | Glaziers' points |
| Leaded glass (stained or clear) | Putty |
| | Labor |

## EXCAVATION

**7. Excavation** is generally measured by the cubic yard, although, in a few localities, measurement by the perch is still in use. If the latter method is adopted, it should be stated just what is meant by a perch, as this varies considerably in different parts of the country.

Before fixing the price for excavation, it is advisable to investigate the character of the soil by making boring tests. Where there is rock to be blasted in making the excavation, a special price should be given in the estimate. If the ground is wet, rendering pumping necessary, provision should be made for the cost of the extra labor needed. The disposition to be made of the excavated material should also be considered; if it must be hauled a long distance, the cost will be much greater than if the soil can be *wasted* near by. To aid in estimating the actual cost, it is convenient and approximately correct to consider 1 cubic yard of ordinary earth as a load for an ordinary two-horse wagon.

In making calculations of the amount of material to be removed, care should be taken to note the existing levels of the ground and those required by the drawings. The excavation should be figured (and made) at least 1 foot greater

than the size of the foundation, so as to provide room for setting the masonry, pointing, etc.

Excavation for pipes, drains, etc. should be at least 9 inches wider than the diameter of the pipe to be laid therein. If the soil in which the excavation is to be made is of a loose and sandy nature that is liable to crumble and slide, a slope, say of 3 inches horizontal to 1 foot vertical, should be allowed on both sides of the trenches. If the latter are of considerable depth, it is sometimes necessary to curb or shore up the sides, in which case an allowance should be made in the estimate for the lumber required. If piles are required, they should be figured at so much per linear foot, driven.

### ACTUAL COST OF EXCAVATION

**8.** In order that an idea may be formed of the actual cost of excavating various kinds of soils, figures based on work actually performed are here given. On this work, for a day of 8 hours, a laborer was paid $2, and a driver with a two-horse team, $4.

As a rule, one laborer can excavate about 7 cubic yards of sandy soil in 8 hours. Thus, at the rate of 25 cents per hour, the cost of excavating this kind of soil is about $28\frac{1}{2}$ cents per cubic yard, provided the material is wasted around the building. To this figure, however, must be added 4 or 5 cents to cover the foreman's wages, the exact amount depending on the number of men under the foreman. This brings the total cost per cubic yard to about 33 cents.

When the material has to be carted away, the cost is further increased. A team with a driver can haul away about 20 cubic yards of soil in a day if the haul is only about $\frac{1}{2}$ mile. In order to do this, however, an extra wagon must be at hand so that the laborers can be loading one wagon while the team is hauling away the other. Thus, the cost of hauling 1 cubic yard of excavated material $\frac{1}{2}$ mile is 20 cents. The total cost, therefore, of excavating 1 cubic yard of sandy soil and hauling it $\frac{1}{2}$ mile is $33 + 20 = 53$ cents.

**9.** If the soil is compact gravel, the cost of excavating, including the foreman's time, will be from 34 to 65 cents per cubic yard, depending on its hardness. It costs about the same to haul compact gravel as it does to haul sandy soil.

The exact cost of excavating wet soil cannot be given, as the conditions encountered may vary in each case. In a stated time, a laborer will excavate nearly as much wet material as dry material, but the conditions of sheet piling and pumping out water makes the price uncertain.

Such excavation is usually carried on at a cost of from 75 cents to $1.25 per cubic yard.

In excavating rock, three men—one rockman and two laborers—usually work together. For a day of 8 hours, the rockman receives $3 and each laborer gets $2. Together, therefore, the wages of the three amounts to $7 a day. These men will excavate about 6 cubic yards of rock in 1 day, making the rock excavation cost $1.17 per cubic yard. To this must be added the cost of explosives, which is about 10 cents per cubic yard, and the wear on tools. This latter expense can hardly be estimated, but may also be considered as 10 cents per cubic yard, thus bringing the total cost of rock excavation up to $1.37 per cubic yard for rock wasted at the building.

**10.** To sum up, excavation in sandy soil wasted around the building costs 33 cents per cubic yard; if hauled $\frac{1}{2}$ mile, it costs 53 cents per cubic yard. If the soil is compact gravel and is wasted around the building, excavation costs from 34 to 65 cents per cubic yard; if hauled $\frac{1}{2}$ mile, from 54 to 85 cents per cubic yard. Wet excavation with no piling or pumping costs about the same as dry; with piling and pumping, it costs from 75 cents to $1.25 per cubic yard. Rock work costs $1.37 per cubic yard if wasted around the building. These figures do not include the contractor's profit.

### CONTRACTOR'S METHOD OF FIGURING EXCAVATION

**11.** Besides the actual cost of excavation, the contractor, in estimating, must include such items as office expenses, builder's profits, etc. The following method of figuring, which is employed by the estimator of a large contracting firm in the eastern part of the United States, will therefore be found useful. As in the preceding case, the prices will be found to vary in different localities; therefore, the figures given should only be used as a guide in estimating.

The prices are based on labor at $2 per day of 8 hours and a two-horse team and driver at $5 per day of 8 hours. The excavation is assumed to be made in ground varying from made ground to a moderately stiff clay. The prices do not include the cost of shoring or pumping, and are based on the assumption that there is no frost of any account while operations are being carried out. Four classes of excavation are recognized:

1. Excavation in trenches up to 5 feet deep, excavated material spread on site about trenches, including back filling around walls, costs from 40 to 50 cents per cubic yard.

2. Trenches from 5 to 10 feet deep, excavated material spread on site adjacent to trenches, including back filling around walls, costs from 65 to 75 cents per cubic yard.

3. For cellars, or similar digging, up to 6 feet deep and having an area large enough to use a plow for loosening the earth (say areas 50 ft. × 20 ft. and over), excavated material being spread on site adjacent to work, costs from 33 to 38 cents per cubic yard if a scoop can be used, and from 40 to 45 cents per cubic yard if the material must be loaded on a wagon to haul it out of the excavation.

4. When the conditions are the same as those just given, except that the excavation is from 6 to 10 feet deep, the price is about 45 cents per cubic yard.

The prices just given do not include hauling, except short hauls immediately in the vicinity of the operations. The cost of hauling will depend on the distance to the place where the material is to be dumped.

**12.** To obtain the cost of any of the classes of excavation just given, including hauling, divide the hire of the team per day by the number of cubic yards that can be removed to the dumping place per day, and increase the preceding prices by that amount.

To figure the cost of sheet piling, measure the area to be sheet-piled and allow for such stringers and braces as judgment may suggest. Since the lumber may be used for other purposes after serving as piling, its value should be estimated at 75 per cent. of the market price. It usually costs about $7 per thousand feet to put the piling in place. As a rule, 3″ × 10″ planks are used for this purpose.

The foregoing prices cover the general run of building work. For large office buildings and other structures of a similar nature, where it is necessary to excavate to a depth of about 25 feet and where several varieties of ground are likely to be encountered, an average price for digging (exclusive of pumping or shoring, but including a haul not exceeding 1 mile) is $1.25 per cubic yard. If large boulders are likely to be encountered in excavating, the price should be at least $1.50 per cubic yard.

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### DITCH WORK

**13.** In estimating the cost of **ditch work**, there are several factors that influence the price. A narrow ditch costs more to dig per cubic yard than a wide one; likewise, a deep ditch costs more than a shallow one. Following are given prices for laying agricultural drain tiling. While these figures do not include builder's profit, they are based on the actual cost of work, the wages for a day of 8 hours being $2 for laborers, $2.50 for the foreman, and $4 for a horse and driver. In sections of the country where higher wages are paid, it will be necessary to increase the figures at a proportional rate when making estimates.

For trenches 3 feet deep and 18 inches wide, in very hard, clay soil with about 10 inches of loam on top, the cost of excavating is about 12 cents per linear foot, or 72 cents

per cubic yard. For filling in the trench with the aid of a team and a scraper, it costs $\frac{3}{4}$ cent per linear foot. For laying a 4-inch tile, including distributing along the trench, the cost is $\frac{3}{4}$ cent per linear foot. For picking stones off of the ground and placing them over the pipe to a depth of about 8 inches, it costs $2\frac{1}{4}$ cents per linear foot. Each outlet built of field stones laid in cement costs from $5 to $8.

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### CALCULATING THE VOLUME OF AN EXCAVATION

**14.** The ordinary rules of mensuration are all that are needed to compute the **volume** of any excavation. The work is very simple when the area to be removed is regular;

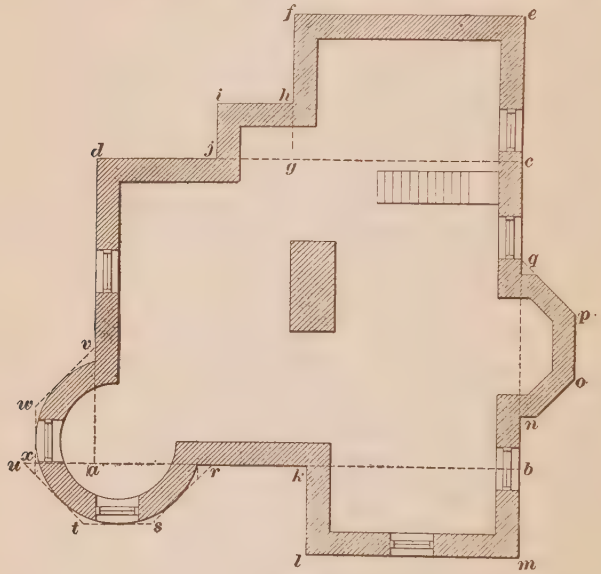


FIG. 1

but when the outlines are very irregular and broken, the easiest method to employ in calculating the excavation is to divide the plan into geometrical figures that are easy to compute, and then calculate the area of each one separately. Adding these areas and multiplying their sum by the depth of the cellar will give the volume of the excavation.

This method will be made clear by referring to Fig. 1, which represents the plan of an irregular foundation. To compute the area of the excavation, the plan is divided into the rectangles *a d c b*, *l k b m*, *j i h g*, *g f e c*, and the polygons *n q p o*, *t u r s*, and *a x w v*. By scaling on the drawing the dimensions of these figures, the area of each may then be readily determined by calculation.

**15.** It is sometimes necessary to find the volume of an excavation, the surface of which is very irregular, as in Fig. 2. In such a case, the following method may be used: Divide the surface of the excavation into a number of

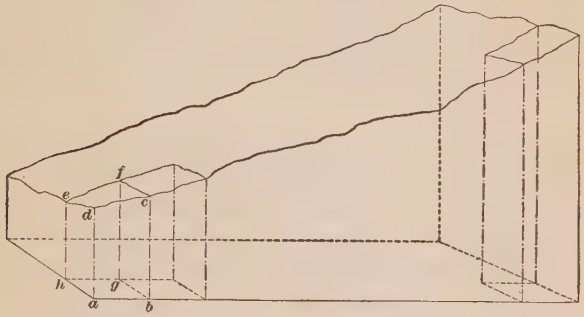


FIG. 2

squares, or rectangles, as at *d e f c*; these represent the ends of prisms, the other ends of which are the bottom of the excavation, as at *a h g b*. Then calculate the volume of each prism by ascertaining the height of the four corners above the bottom; add these measurements together, divide the sum by 4 (the number of corners), and multiply the result by the end area, as *a h g b*; the product will be the volume of the prism. The sum of these partial volumes will be an accurate estimate of the contents of the excavation.

## CONCRETE WORK

**16. Plain concrete work** is usually paid for by the cubic yard. The contractor furnishes all material, including the lumber, to make the forms; he also erects the forms and removes them after the concrete has been placed. There is no fixed practice regarding openings in walls. Usually, small openings under, say, 100 square feet in superficial area are considered as solid. All larger openings are deducted from the work when measuring for payment. In some localities, the actual volume of the concrete work is taken by the contractor as a basis of the cost. In either case, it is of prime importance that the architect and the contractor make some distinct agreement *beforehand* as to exactly how the concrete work is to be measured and paid for.

**Reinforced-concrete work** is also often measured by the cubic yard, although sometimes it is contracted for as a finished building. The steel reinforcement is sometimes included in the price. Often, patented steel reinforcement is bought separately and delivered to the contractor; at other times, the contractor buys the patented steel or else makes it and pays a royalty to the holder of the patent. Reinforced-concrete floors are sometimes measured by the cubic yard and sometimes by the square yard, according to agreement. Pavements are usually measured by the square foot or by the square yard.

In Table II are given the costs of stone concrete and gravel concrete. These figures do not include builder's profit, cost of superintendence, or cost of forms. They are based on the following costs: Labor, 25 cents per hour; cement, $2 per barrel; sand, $1.50 per cubic yard; crushed stone, $1.65 per cubic yard; gravel, $1 per cubic yard.

To the values given in the table, the price of the wooden forms, both for material and erection, must be added. This of course varies considerably, according to whether the work is straight or has a number of corners and openings in it.

## TABLE II

### COST OF PLAIN STONE CONCRETE

| Mixture | | | Quantity | | | Cost | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Cement Parts | Sand Parts | Broken Stone Parts | Cement Barrels | Sand Cubic Yards | Broken Stone Cubic Yards | Cement | Sand | Broken Stone | Labor | Total |
| 1 | 2 | 4 | 1.5 | .45 | .90 | $3.00 | $ .68 | $1.49 | $ .75 | $5.92 |
| 1 | 3 | 5 | 1.1 | .50 | .85 | 2.20 | .75 | 1.40 | .75 | 5.10 |
| 1 | 3 | 6 | 1.0 | .45 | .90 | 2.00 | .68 | 1.49 | .75 | 4.92 |

### COST OF PLAIN GRAVEL CONCRETE

| Mixture | | | Quantity | | | Cost | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Cement Parts | Sand Parts | Gravel Parts | Cement Barrels | Sand Cubic Yards | Gravel Cubic Yards | Cement | Sand | Gravel | Labor | Total |
| 1 | 2 | 4 | 1.3 | .4 | .80 | $2.60 | $ .60 | $ .80 | $ .75 | $4.75 |
| 1 | 3 | 5 | 1.0 | .5 | .80 | 2.00 | .75 | .80 | .75 | 4.30 |
| 1 | 3 | 6 | .9 | .4 | .85 | 1.80 | .60 | .85 | .75 | 4.00 |

The price of forms, including both material and erection, may be said to vary from 50 cents for ordinary cellar work to $2 for heavy retaining walls per cubic yard of concrete placed.

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### DATA ON REINFORCED-CONCRETE BUILDING

**17.** The cost of **reinforced-concrete buildings** varies with the market price of cement and the steel bars or metal used for reinforcing. At present, reinforced-concrete buildings of the factory type constructed of common, hard, stretcher-brick walls and reinforced-concrete floors, roof, and columns with foundations may be built for from $1.35 to $1.65 per square foot of floor area. Usually, the height of ceilings in factory buildings is about 14 feet from floor to floor, thus making the cost of this type of building approximately from 10 to 12 cents per cubic foot. For buildings of a better commercial type, with face-brick walls and terra-cotta trimmings, the cost per square foot of floor area will range from $1.65 to $1.90, making the cost per cubic foot from 12 to 14 cents.

Reinforced-concrete buildings, as a rule, exceed the cost of buildings of slow-burning construction of the same size by an amount about equal to the cost of the metallic reinforcement. In other words, a building of reinforced concrete costs from 10 to 25 per cent. more than the same building of slow-burning construction.

The price of reinforced concrete per cubic yard varies within wide limits, depending on the mass of concrete employed and the intricacies of the forms. In building construction, reinforced concrete, including the price of the forms, can usually be placed for from $12 to $18 per cubic yard, the cost of the steel reinforcement being added.

Where the building is of considerable height, the same forms used in the three lower stories may be used in constructing the balance of the building. In such a case, the cost of the forms will probably not exceed $6 for each cubic yard of concrete placed. If the building is only two or three stories in height, and the work is rushed by using new

centering in each floor, the cost of the forms will range from $7 to $9 per cubic yard of concrete.

The cost of form work for floor construction will range from 10 to 12 cents per square foot. Column forms will cost in the neighborhood of 20 or 25 cents per running foot. The forms used for fine concrete-wall construction require considerable time and bracing, and generally must be executed with great care where finished work is required. Such forms will cost from 8 to 10 cents per square foot of form on both sides of the wall, but will greatly exceed this price if molded courses or paneled spandrels are to be formed and lettering is to be cut in the work.

**18.** In estimating the cost of **reinforced-concrete slabs,** the cost of the centering, the concrete, and the steel reinforcements must be considered. The cost of centering for slab work varies from 5 to 7 cents per square foot, the latter figure probably being more nearly correct for usual conditions. The concrete for plain reinforced-concrete slab construction on steel beams can be placed for about $5.60 per cubic yard, or $1\frac{3}{4}$ cents for a square foot 1 inch in thickness. At present market values, the steel for reinforcing slabs can usually be considered as costing about 3 cents a pound, the pound price increasing as the rods decrease in size.

Table III gives the approximate cost, in cents per square foot, of constructing different thicknesses of reinforced-concrete slabs on steel-beam construction with the different sizes of reinforcing bars usually employed. The prices include cost of centering, concrete, and steel reinforcement.

**19.** Table III cannot be used for estimating the cost of a reinforced-concrete floor with reinforced-concrete beams and girders. In the construction of such a floor, the centering is much more costly than where steel beams are used for the support of the floor slab. On an average, the centering for the reinforced-concrete floor systems, including the studding and shoring, will cost from 20 to 22 cents per square foot, the sides of the beam and girder forms being included

in the square-foot estimate. This cost is materially reduced where the centering is used over and over again for the construction of upper floors, so that where the building is six or eight stories in height, the average cost of the centering will not exceed 10 or 12 cents per square foot, including shoring, as just mentioned. Owing to the difficulty encountered in placing the concrete in the beams, the tamping required with slice bars, etc., and the expense of placing the reinforcement, the concrete for such construction will cost about $7.50 or $8 per cubic yard. The steel for the entire construction will usually average from

TABLE III

COST IN CENTS PER SQUARE FOOT OF REINFORCED-CONCRETE FLOOR SLABS SUPPORTED ON STEEL BEAMS

| Thickness of Slab Inches | $\frac{5}{16}$-Inch Diameter Rods at 6-Inch Centers | $\frac{3}{8}$-Inch Diameter Rods at 6-Inch Centers | $\frac{7}{16}$-Inch Diameter Rods at 6-Inch Centers | $\frac{1}{2}$-Inch Diameter Rods at 6-Inch Centers | $\frac{5}{8}$-Inch Diameter Rods at 6-Inch Centers |
|---|---|---|---|---|---|
| $3\frac{1}{2}$ | 14.87 | 15.58 | | | |
| 4 | 15.75 | 16.46 | 17.24 | | |
| $4\frac{1}{2}$ | 16.62 | 17.33 | 18.11 | 18.87 | |
| 5 | 17.50 | 18.21 | 19.00 | 19.75 | 20.87 |
| $5\frac{1}{2}$ | 18.37 | 19.08 | 19.87 | 20.62 | 22.62 |
| 6 | 19.25 | 19.96 | 20.75 | 21.50 | 23.50 |

3 to 4 cents a pound, depending on whether plain rods or deformed bars are used, or whether the system is made up of loose rods or fabricated frames. In estimating the cost of such a floor system, the centering should be figured by a carefully itemized estimate, or roughly from the preceding figures. The amount of concrete in both the slab beams and columns should be estimated, and the total number of cubic yards required for the entire work should be determined; then the unit price for providing and placing the concrete should be carefully considered with reference to local conditions of labor and cost of material.

### CEMENT CELLAR FLOORS

**20.** In determining the cost of **cement cellar floors,** the concrete proper and the top coat should be considered separately. The concrete proper is usually reckoned by the cubic yard. About 1 hour more is required to lay a cubic yard of floor than is necessary for plain concrete work. Therefore, in estimating, 25 cents per cubic yard, or the wages of a laborer for 1 hour, must be added to the figures given in Table II. A 1–3–6 mixture is generally used. For stone concrete, then, the cost of the concrete proper for a cement cellar floor would be $5.17 per cubic yard, exclusive of the cost of supervision and the builder's profit.

An analysis of the cost per square yard of top coat 1 inch thick for a cement cellar floor is as follows:

| | Cost Cents |
|---|---|
| $\frac{1}{4}$ hour, plasterer's time, at 45 cents per hour | $11\frac{1}{4}$ |
| $\frac{1}{4}$ hour, laborer's time, at 25 cents per hour | $6\frac{1}{4}$ |
| $\frac{1}{16}$ barrel of cement, at $2 per barrel | $13\frac{1}{3}$ |
| $\frac{1}{8}$ barrel of white sand, at 75 cents per barrel | $9\frac{3}{8}$ |
| Approximate cost per square yard | 40 |

To the foregoing should be added the cost of supervision and builder's profit.

### CONCRETE BUILDING BLOCKS

**21. Concrete building blocks** usually present about 2 square feet of surface in the wall and are generally 8 inches thick, thus making a volume of $1\frac{1}{3}$ cubic feet. Since one-third of this volume as a rule is air space, the actual volume of concrete is a little less than 1 cubic foot. The materials in a block of this kind, if used in a 1–4 mixture, will cost about 18 cents. If the block is 12 inches thick instead of 8 inches, the materials will cost about half again as much, or 27 cents. The cost of labor to manufacture these blocks depends on whether they are made in great quantities, and the wages paid the workmen, etc., and varies from 6 to $10\frac{1}{2}$ cents for each block. To lay a block in the wall costs from

5 to 10 cents, 7 cents being about the average price. This price includes the mortar used in laying. For teaming and haulage, an allowance of 5 cents per block is usually sufficient. The cost per block, 8 inches thick, set in the wall is then as follows:

| | Maximum Cost Cents | Minimum Cost Cents |
|---|---|---|
| Materials | 18 | 18 |
| Labor | $10\frac{1}{2}$ | 6 |
| Placing | 10 | 5 |
| Haulage | 5 | none |
| Total | $43\frac{1}{2}$ | 29 |

These results divided by 2 will give the cost of the wall per square foot, since each block is supposed to have a surface of 2 square feet. If the wall is 12 inches thick instead of 8 inches, one-half as much again should be added to the price.

## MASONRY

**22.** **Stone masonry** is generally measured by the perch; in some sections of the United States, however, measurement by the cord is preferred, but the best method (as being invariable) is by the cubic yard. In estimating by the perch, it is necessary to state how much the perch is taken at, whether $24\frac{3}{4}$ or 25 cubic feet. Note should also be made in regard to corners and deduction for openings. In most localities it is not customary to deduct openings under a certain size, and corners are usually measured twice.

**23.** Rough stone from the quarry is generally sold under two classifications; namely, *rubble* and *dimension stone*. **Rubble** consists of pieces of irregular size, such as are most easily obtained from the quarry, up to 12 inches in thickness by 24 inches in length. Stone ordered of a certain size, or to square over 24 inches each way and to be of a particular thickness, is called **dimension stone.**

Rubble masonry and stone backing are generally figured by the perch or cubic yard. Dimension-stone footings are

measured by the square foot unless they are built of large, irregular stone, in which case they are measured the same as rubble. Ashlar work is always figured by the superficial foot; openings are usually deducted, and the jambs are measured in with the face work. Flagging and slabs of all kinds, such as hearths, treads for steps, etc., are measured by the square foot; sills, lintels, molding, belt courses, and cornices, by the linear foot; and irregular pieces, by the cubic foot. All carved work is done at an agreed price by the piece.

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### DATA ON RUBBLE MASONRY

**24.** The following proportions and cost of materials and amount of labor required to lay 1 perch of rubble masonry are reasonably accurate, and will serve to give an idea of how to estimate such work. A perch of rubble masonry requires, approximately, 2,500 pounds of stone.

COST OF RUBBLE MASONRY

*Using 1-to-3 Lime Mortar*

| | |
|---|---|
| 1 perch of stone (25 cubic ft.) delivered at work | $1.25 |
| 1 bushel of lime | .25 |
| $\frac{1}{6}$ cubic yard of sand, at $1.50 per cubic yard | .25 |
| $\frac{1}{2}$ day, mason's labor, at $3.20 per day | 1.60 |
| $\frac{1}{4}$ day, helper's labor, at $2 per day | .50 |
| Total | $3.85 |

*Using 1-to-3 Portland-Cement Mortar*

| | |
|---|---|
| 1 perch of stone | $1.25 |
| $\frac{3}{4}$ barrel of Portland cement, at $2 per barrel | 1.50 |
| $\frac{1}{4}$ cubic yard of sand, at $1.50 per cubic yard | .38 |
| $\frac{1}{2}$ day, mason's labor, at $3.20 per day | 1.60 |
| $\frac{1}{4}$ day, helper's labor, at $2 per day | .50 |
| Total | $5.23 |

To the preceding amounts should be added the cost of scaffolding and the builder's profit. If the walls are over two stories in height, 60 cents per perch extra for hoisting should be added.

### DATA ON FLAGSTONES AND CURBING

**25. Flagstones** for sidewalks, ordinary stock, natural surface, 3 inches thick, with joints pitched to line, in lengths (along walk) from 3 to 5 feet, will cost, for a 3-foot walk, about 11 cents per square foot (if 2 inches thick, 10½ cents); for a 4-foot walk, 12 cents; and for a 5-foot walk, 16 cents. The cost of laying all sizes will average about 3 cents per square foot. These figures do not include cost of hauling.

Curbing, 4 in. × 24 in., granite, will cost from 40 to 50 cents per linear foot at the quarry; digging and setting will cost from 10 to 12 cents additional; and the cost of freight and hauling must also be added.

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### DATA ON ASHLAR AND CUT STONE

**26.** The following figures are average prices for **ashlar facing** when the transportation charges are not excessive, and are not given as fixed values, but more to show the relative costs. They include nothing but plain ashlar, and in estimating, the extra cost of sills, lintels, water-tables, belt courses, coping, etc. must be added. These prices are based on quarrymen's wages of $2.50 per day, and stonecutters' wages of $4 per day.

Good rock-face bluestone ashlar, with from 6- to 10-inch beds, dressed about 3 inches from face, will cost, ready for laying, from 30 to 40 cents per square foot, face measure; while a higher grade of work will cost from 40 to 55 cents per square foot. Regular course bluestone ashlar, from 12 to 18 inches high and with from 8- to 12-inch beds, will cost about 50 cents per square foot. To this (and the previous figures) must be added the cost of hauling, which, on an average, will be about 3 cents per square foot.

To the preceding figures must also be added the cost of setting the ashlar. In estimating the cost of ashlar walls backed with brick, the wall is considered as solid brick, the cost of setting the ashlar being offset by the saving in cost of the brick and mortar and the labor resulting from making

part of the thickness of the wall of stone. The cost of raking out the joints and pointing, which amounts to about 10 cents per square foot, must also be added.

**27.** The following figures show the approximate cost of cut bluestone for various uses:

| | |
|---|---|
| Flagstone, 5-inch, size 8′ × 10′, edges and top bush-hammered, per sq. ft., face measure | $ .75 |
| Flagstone, 4-inch, size 5′ × 5′, select stock, edges clean cut, natural top, per sq. ft. | .45 |
| Door sills, 8″ × 12″, clean cut, per lin. ft. | 1.35 |
| Window sills, 5″ × 12″, clean cut, per lin. ft. | .80 |
| Window sills, 4″ × 8″, clean cut, per lin. ft. | .45 |
| Window sills, 5″ × 8″, clean cut, per lin. ft. | .60 |
| Lintels, 4″ × 10″, clean cut, per lin. ft. | .65 |
| Lintels, 8″ × 12″, clean cut, per lin. ft. | 1.25 |
| Steps, sawed stock, 7″ × 14″, per lin. ft. | 1.10 |
| Water-table, 8″ × 12″, clean cut, per lin. ft. | 1.25 |
| Coping, 4″ × 21″, clean cut, per lin. ft. | 1.20 |
| Coping, 4″ × 21″, rock-face edges and top, per lin. ft. | .50 |
| Coping, 3″ × 15″, rock-face edges and top, per lin. ft. | .35 |
| Coping, 3″ × 18″, rock-face edges and top, per lin. ft. | .40 |
| Platform, 6 inches thick, per sq. ft. | .50 |

To the preceding prices of cut stone must be added the cost of setting, which for water-tables, steps, etc. will be about 10 cents per linear foot; and for window sills, etc., about 5 cents per linear foot. In addition, about 10 cents per cubic foot for fitting, and about 5 cents per cubic foot for trimming the joints after the pieces are set in place, should be allowed.

**28.** In a day of 8 hours, a stone cutter can cut about 4 square feet of granite, about 6 square feet of bluestone, or about 8 square feet of Ohio sandstone or limestone. These figures are for 6-cut, patent-hammered work. For rock-face ashlar (beds worked about 3 inches from face, the rest

pitched), a workman can dress from 15 to 25 square feet of random ashlar per day; and from 18 to 20 square feet of coursed ashlar. In dressing laminated stone, from two to three times more work can be done in a day on the natural surface than on the edge of layers. In figuring cut stone, ample allowance should be made for waste, which, on an average, will be 15 per cent.

### ADDITIONAL METHOD OF ESTIMATING ASHLAR

**29.** The following method of estimating the cost of cut stone is employed by many practical stone men. It is based on the fact that most ashlar walls have about the same number of sills, belt courses, lintels, water-tables, etc. in proportion to their volume, and therefore all the stonework, both the ashlar proper and the other cut stone, may be lumped together at one price per cubic foot. For estimating purposes, stone may be divided into two classes: *soft stone*, such as the sandstones, and *hard stone*, such as the granites.

**30. Soft Stone.**—Indiana limestone may be taken as an example of soft stone. In the Eastern Pennsylvania district, where the stone cutters' wage rate is 50 cents per hour, the cost of this kind of stone is about as follows:

| | |
|---|---|
| Rough blocks, per cubic foot | $ .75 |
| Sawing, jointing, cutting, rubbing, waste in stock | 1.50 |
| Total | $2.25 |

If the work is tooled, which is preferable for this material, 20 cents per cubic foot should be added. Thus the value in the yard, but ready to set, for an ashlar front, including water-table, sills, lintels, belt courses, all ordinary moldings, and plain cornices, is $2.45 per cubic foot.

Consoles, dentils, panelings, and similar ornamental work, mantels, and interior work have no fixed prices, but must be governed by the estimator's knowledge of time required to cut any particular kind, sometimes reaching $5 per cubic foot. If moldings are deeply undercut, an extra price will have to be charged.

In heavy work, where the amount of stock is large compared with the amount of dressing, deductions may be made that sometimes amount to as much as 20 per cent. Rock-face work is somewhat more expensive than plain, dressed work because the projecting rock surface requires more stock; therefore, about 10 per cent. should be added.

It is customary to leave stone roughly cut to shape for carving in the wall, and therefore the sculptor determines the value from the drawings and includes the cost of models, which must be approved by the architect before the work is cut. Circular work, if plain, costs about the same as square work, but if fluted or reeded, as in the case of columns, it may cost as much as 50 per cent. additional.

**31.** Compared with limestone, the prices of other soft stones are as follows:

| | Cost of Stock | For Cutting Per Cent. |
|---|---|---|
| Connecticut brownstone | $1.25 | 20 |
| Long Meadow brownstone | 1.25 | 30 |
| Portage red stone | 1.05 | 30 |
| Vermont or Georgia white marble | 2.15 | 50 |
| Pennsylvania blue marble | 2.00 | 50 |
| Bluestone | .80 | 30 |

No definite price can be given for marble, as it comes in different grades and varieties.

The prices of stock just given are for stones of common size. If extra-large or extra-long stones are required, their price per cubic foot will be greater.

The cost of transportation from the quarries also influences the price of stone. This cost will vary according to the distance of the quarry from the location where the stone is to be used. The cost of hauling stone from the yard and setting it in the wall runs from 40 to 50 cents per cubic foot.

**32. Granite.**—Final estimates of cut granite by the cubic foot are seldom made, although approximate estimates are often made in that way by comparing a proposed piece of work with a similar one already completed. The reason

for not making final estimates is that every additional molding or break in granite work affects the cost considerably, differing greatly in this respect from soft stone.

The first note to be made by the estimator is in regard to the cost of material. Good granite, in dimension sizes, can be obtained from southern quarries by rail for 65 cents per cubic foot, delivered. The same expenditure will buy very good eastern granite where through water transportation is available. If, however, the granite specified is such that it must be obtained from eastern quarries having only rail facilities for shipment, an addition of 40 or 50 cents per cubic foot will be required. There are also some special grades of granite that cost $1.50 or more per foot. In shipping granite, the railroads usually allow 8 cubic yards to the car. Granite for monumental purposes costs from $1.25 to $5 per foot, according to the size and quality. At wholesale, the price first mentioned, namely, 65 cents per cubic foot, will buy as good, substantial, and handsome material as will generally be required.

**33.** Machinery is used extensively for cutting plain faces in granite, and also to some extent for moldings and carved work. Every line in granite is costly to cut and must be computed separately. For instance, a plain face 12 inches wide, if cut by machinery, will cost 45 cents per square foot,

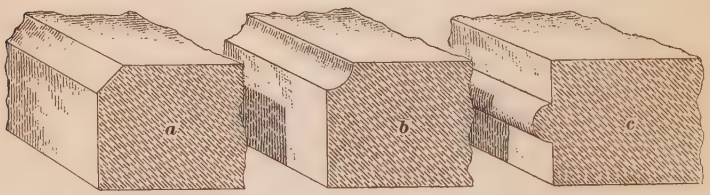


FIG. 3

while if cut by hand, where the machine cannot be applied, it will cost 60 cents. A 2-inch bevel, as shown at *a*, Fig. 3, will cost 50 cents per linear foot additional. A scotia, as shown at *b*, or other molding, as at *c*, will cost 60 cents per linear foot additional for each member.

All returns, no matter how small, must be counted as not less than 1 foot. Circular work costs from 50 to 100 per cent. more than straight work. Flutes or reeds in columns are very expensive, and must be calculated in each case according to the width and depth. All beads and joints should be counted at say 30 cents per square foot. All notches or rabbets are counted separately, according to shape and size.

The preceding prices are based on what is called patent-hammered, six-cut work. Eight-cut work will cost 15 per cent. more, and ten-cut work, which is seldom used in ordinary building work, brings $1 per square foot. Rock-face work in granite is cheaper than hammered work. A good, clean rock face should be counted at 20 cents per square foot. Axed, or peen-hammered, work is between rock face and six cut.

Polishing plain surfaces costs $1 per square foot in addition to the cost of cutting, surfaces having widths of 4 inches and under counting as 6 inches, and those over 6 inches up to 12 inches counting as 1 foot.

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## BRICKWORK

**34. Brickwork** is generally estimated by the thousand bricks laid in the wall, but measurements by the cubic yard and the perch are also used. The following data will be useful in calculating the number of bricks in a wall. For each superficial, or square, foot of wall 4 inches (the width of one brick) in thickness, allow $7\frac{1}{2}$ bricks; for a 9-inch (the width of two bricks) wall, count 15 bricks; for a 13-inch (the width of three bricks) wall, allow $22\frac{1}{2}$ bricks; and so on, estimating $7\frac{1}{2}$ bricks for each additional 4 inches in thickness of the wall. The preceding figures are for bricks about $8\frac{1}{2}$ in. $\times$ 4 in. $\times$ $2\frac{1}{4}$ in. in size. If smaller bricks are used, the thickness of the walls will be decreased proportionately.

If brickwork is estimated by the cubic yard, allow 500 bricks to a yard. This figure is based on the use of bricks of the size just given and mortar joints not over $\frac{3}{8}$ inch thick.

If the joints are $\frac{1}{8}$ inch thick, as in face brickwork, 1 cubic yard will require about 575 bricks. In making calculations of the number of bricks required, an allowance of, say, 5 per cent. should be made for waste in breakage, etc.

The practice in regard to deductions for openings is not uniform throughout the United States, but, usually, small openings are counted solid, as the cost of the extra labor and the waste in working around these places balances that of the brickwork saved. All large openings, 100 square feet or over in area, should be deducted. When openings are measured solid, it is not customary to allow extra compensation for arches, pilasters, corbels, etc.

Rubbed and ornamental brickwork should be measured separately, and charged for at a special rate.

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### DATA ON BRICKWORK

**35.** The following estimates on the cost of brickwork are very carefully compiled, and will be found trustworthy. It should be understood that the prices will vary with the cost of materials and labor; the proportions, however, will be constant. The figures are based on *kiln*, or actual, count; that is, with deductions for openings. When the work is measured with no deductions for openings, the cost per thousand may be assumed as about 15 per cent. less than the prices given, which are exclusive of scaffolding, hoisting, and builder's profit. The scaffolding will cost, according to conditions of the structure and site, from 5 to 7 per cent. of the prices given.

Cost of Common Brickwork per Thousand Bricks

*Using 1-to-3 Lime Mortar*

| | |
|---|---|
| 1,000 bricks | $8.00 |
| 2 bushels of lime, at 25 cents per bushel | .50 |
| $\frac{1}{2}$ cubic yard of sand, at $1.50 per cubic yard | .75 |
| Bricklayer, 8 hours, at 55 cents per hour | 4.40 |
| Laborer, 8 hours, at 25 cents per hour | 2.00 |
| Total | $15.65 |

*Using 1-to-3 Portland-Cement Mortar*

| | |
|---|---|
| 1,000 bricks | $8.00 |
| 1 barrel of Portland cement | 2.00 |
| ½ cubic yard of sand | .75 |
| Bricklayer, 8 hours, at 55 cents per hour | 4.40 |
| Laborer, 8 hours, at 25 cents per hour | 2.00 |
| Total | $17.15 |

*Using 1-to-4 Lime-and-Cement Mortar*

| | |
|---|---|
| 1,000 bricks | $8.00 |
| ¾ bushel of lime, at 25 cents per bushel | .19 |
| ½ cubic yard of sand | .75 |
| ⅔ barrel of cement, at $2 per barrel | 1.34 |
| Bricklayer, 8 hours, at 55 cents per hour | 4.40 |
| Laborer, 8 hours, at 25 cents per hour | 2.00 |
| Total | $16.68 |

COST OF STRAIGHT, PRESSED BRICKWORK, PER THOUSAND BRICKS

*Using Lime-Putty Mortar*

| | |
|---|---|
| 1,000 pressed bricks, cost from $20 to $40 (average) | $30.00 |
| 1½ bushels of lime | .38 |
| ¼ cubic yard of fine sand | .38 |
| Bricklayer, 27 hours, at 60 cents per hour | 16.20 |
| Laborer, 27 hours, at 25 cents per hour | 6.75 |
| Total | $53.71 |

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### ESTIMATING BRICKWORK

**36.** The following figures and method of estimating brickwork were supplied by an estimator of a large eastern contractor. The prices given include office expense and builder's profit. The wages per hour on which these figures are based are: Bricklayers, 65 cents; hod carriers, 25 cents; and common laborers, 18 cents.

Following are mentioned four distinct classes of brick buildings, and in Table IV are given the labor prices per thousand brick for the various stories of buildings of these classes.

1. Absolutely plain factory buildings.

2. Factory or office buildings broken up with a few pilasters and other projections; stretcher-brick facing, neatly cleaned down and pointed.

3. Office buildings of fairly ornamental type, well broken up with pilasters, projecting courses, etc., with pressed-brick facing.

4. Highly ornamental brick buildings, molded cornices, pilasters, raised quoins, sunk molded panels, and numerous flat and segmental arches.

TABLE IV

LABOR PRICES PER THOUSAND BRICK FOR FOUR CLASSES OF BRICK BUILDINGS

| Part of Building | Class 1 | Class 2 | Class 3 | Class 4 |
|---|---|---|---|---|
| Basement . . . . . | $ 7.50 | $ 7.50 | $ 8.50 | $ 9.50 |
| First floor . . . . . | 8.00 | 9.00 | 10.50 | 13.50 |
| Second floor . . . . | 8.50 | 10.00 | 11.00 | 14.00 |
| Third floor . . . . . | 9.00 | 10.50 | 11.50 | 14.50 |
| Fourth floor . . . . | 9.50 | 11.00 | 12.00 | 15.00 |
| Fifth floor . . . . . | 10.00 | 11.50 | 12.50 | 15.50 |
| Sixth floor . . . . . | 11.00 | 12.00 | 13.00 | 16.00 |

The prices in the table include the cost of mortar. If the cost of brick at building is added, the result will be the total cost of brickwork exclusive of scaffolding. The average price of total brick labor in buildings of class 1 is $8.50; of class 2, $9.50; of class 3, $11.50; and of class 4, $14.

**37.** The following miscellaneous brick prices, including labor and mortar, but not brick, are from the same source as the prices given in the preceding article, and are based on the same condition, the prices being in bricks per thousand:

For heavy basement walls and similar masses of brickwork . . . . . $ 7.00

For 18-inch brick walls not over two or three stories high, in hard brick with struck joints 8.00

| | |
|---|---|
| Same as above, but for 13-inch walls . . . . | $ 9.00 |
| For 18-inch brick walls, as above, but faced on one side with pressed brick . . . . . | 12.00 |
| For 18-inch brick walls, as above, but faced on both sides with pressed brick . . . . . | 16.50 |
| For 13-inch brick walls, as above, but faced one side with pressed brick . . . . . | 14.00 |
| For 13-inch brick walls, as above, but faced both sides with pressed brick . . . . . | 14.00 |
| Add to above, if of English or Flemish bond, on entire cost of wall . . . . . | .50 |
| If work is broken up into light piers, requiring a lot of plumbing, add to cost of wall as above . . . . . | 1.50 |
| If a large number of segmental arches must be turned, add to total cost of wall . . . | 1.00 |

In addition to the preceding schedule two useful rules to remember are: For pressed-brick segmental arches, add for labor 1½ times the cost of bricks; for pressed-brick arches requiring radial brick, add for labor twice the cost of straight, pressed brick. As radial brick are shipped to the building in barrels and have to be unpacked and laid out on the full-sized diagram on the floor, it will be found that the rate given is not excessive.

For brick vault arches, the cost of labor, exclusive of mortar, will be about $5 per thousand brick. If pointed underneath, 7 cents per square foot will have to be added. If the centers are left in place until the mortar has set, it will be necessary to rake out the joints and wet them before pointing. This will cost about 10 cents per square foot.

---

### TERRA-COTTA WORK

**38. Terra-Cotta Floor Arches.**—The cost of **terra-cotta floor arches** varies somewhat with the span and with the difficulties encountered in putting up and removing the centering. If the building consists of a number of stories, the centering that is used on one floor may be reused on a

floor several stories higher up, in this way decreasing the outlay for centerings. For ordinary spans, the following analysis of the cost of a 12-inch arch, exclusive of the cost of the terra cotta itself, will be found quite accurate, provided the centering is put up by experienced laborers. The price given is per square foot of arch.

| | Cents |
|---|---|
| Centering | 3 |
| Hoisting and laying | 3½ |
| Mortar | ½ |
| Total | 7 |

This price is for work showing a flat ceiling. If the ceiling is much broken up by girders, the price, exclusive of the terra cotta itself, will be about 8 cents per square foot.

As a price per square foot, including the cost of terra cotta, setting, and mortar, the following figures may be taken. These, however, do not include the cost of plastering, or of any concrete fill above the terra cotta.

| | Cents |
|---|---|
| 10-inch arches | 23 |
| 12-inch arches | 25 |
| 15-inch arches | 29 |

**39. Terra-Cotta Partitions.** — In office buildings, **terra-cotta partitions** are usually erected on top of a

TABLE V

COST OF TERRA-COTTA PARTITIONS

| Thickness Inches | Cost of Setting per Square Foot, Including Mortar Cents | Cost of Terra Cotta per Square Foot Cents | Total Cost per Square Foot Cents |
|---|---|---|---|
| 3 | 5 | 9 | 14 |
| 4 | 5 | 10 | 15 |
| 6 | 6 | 12 | 18 |
| 10 | 8 | 16 | 24 |

floor in order to divide the space into such rooms as will suit the tenants. This work is generally done after the building is otherwise completed. An analysis of the cost of such partitions is given in Table V.

The cost of placing 8-inch, terra-cotta backing to brickwork is 6 cents per square foot.

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### TILING

**40.** Although not always of a brick or terra-cotta nature, it will be found more convenient to consider all **tiling** together and at the same time that the cost of brickwork is taken up.

Only very general figures can be given on the cost of tiling, as this cost depends considerably on the design to be carried out. The cost per square foot of various styles of tile laid in place is as follows:

| | |
|---|---|
| Moravian tile floors | $1.50 |
| Interlocking, rubber tile floors | 1.50 |
| Columbia marble tile, 12″ × 12″, with colored border, tile laid straight on floor | .50 |
| Columbia marble tile, 12″ × 12″, with colored border, tile laid diagonally on floor | .60 |
| Italian marble tile, 12″ × 12″, with colored border, tile laid straight on floor | .70 |
| Italian marble tile, 12″ × 12″, with colored border, tile laid diagonally on floor | .80 |
| Terrazzo and marble mosaic border | .38 to .40 |
| Common, white tile in vertical locations, as lining for elevator shafts, etc. | .40 |
| Marble mosaic ceiling work | 3.00 |
| Marble and glass mosaic ceiling work | 8.00 |
| 2-inch book tile (laying only) | .04 |
| 3-inch book tile (laying only) | .04 |
| Shoe tile (laying only) | .06 |

### MACKITE

**41. Mackite** is a fireproofing material used for partitions in very much the same way as terra cotta. As this material is put in place by bricklayers, its cost will be taken up here.

Where there are many openings, two bricklayers and one laborer can set 240 square feet of mackite in 8 hours; in a straight wall, without openings, these same men can set about 400 square feet. The market price for $2'' \times 12'' \times 30''$ blocks is 6 cents per square foot; for blocks 3 inches thick, it is 8 cents per square foot. The average price for both material and labor for 2-inch mackite is 10 cents per square foot; for 3-inch material it is about 12 cents per square foot.

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## CARPENTRY

**42. Carpentry** should include general framing, roofs, floor joists, partitions, sheathing, flooring, furring, and plastering grounds.

**43. Board Measure.**—The rough lumber used in framing is measured by the **board foot,** which means a piece 12 inches square and 1 inch thick. Lumber is always sold on a basis of a thousand feet **board measure.** The customary abbreviation for the latter term is B. M.; that for *thousand* is M. Thus, 500 feet board measure, costing $27 per thousand, would be written: 500 ft. B. M., at $27 per M.

To obtain the number of board feet in any piece of timber, the length, in inches, should be multiplied by the end area, in square inches, and the result divided by 144. For example, the number of feet B. M. in a floor joist 20 feet long, 3 inches thick, and 10 inches deep is 240 inches ($= 20$ feet $\times$ 12) multiplied by 30 square inches (the end area) divided by 144, or 50.

The following rule is used by most contractors and lumber dealers: *Multiply the length in feet by the thickness and width in inches, and divide the product by 12.* Thus, a scantling

26 feet long, 2 inches thick, and 6 inches wide contains $\frac{26 \times 2 \times 6}{12} = 26$ feet B. M.

This rule, expressed in a slightly different manner, is more convenient for mental computation: *Divide the product of the width and thickness in inches by 12, and multiply the quotient by the length in feet.* Thus, a $2'' \times 10''$ plank, 18 feet long, contains $\frac{2 \times 10}{12} \times 18 = 30$ feet B. M.

**44. Prices of Lumber.**—Owing to the continual variation in the prices and grades of lumber, it is impossible to give prices here that will not vary from day to day. The architect before starting to estimate should first be sure that he has the latest lumber prices obtainable. These prices can always be secured from the local lumber dealer.

**45. Studs.**—To calculate the number of **studs**—set on 16-inch centers—the following rule may be used: *From the length of the partition, in feet, deduct one-fourth, and to this result add 1. Count the number of returns, or corners, on the*

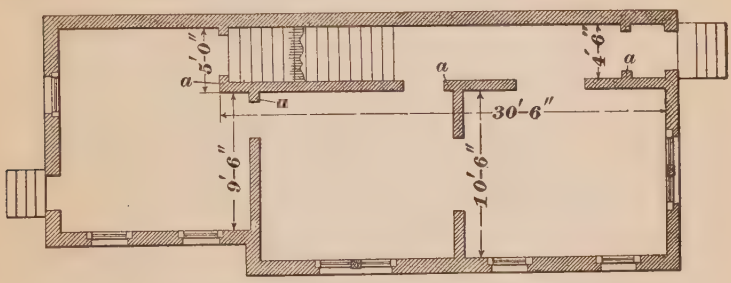



FIG. 4

*plan, where double studding is required, and add 2 studs for each such return.* (The reason for adding 1 is to include the stud at the end, which would otherwise be omitted.) The sills, plates, and double studs must be measured separately.

For example, the number of studs required for partitions only, shown on the plan, Fig. 4, is computed in the following manner.

30 ft. 6 in.
10 ft. 6 in.
9 ft. 6 in.
5 ft. 0 in.
4 ft. 6 in.
60 ft. 0 in.

Deducting one-quarter from 60 feet, the remainder is 45 feet; adding 1 stud, the result is 46 feet. As there are 4 returns, with 2 studs for each, as shown at *a a*, the total number is $46 + (4 \times 2) = 54$ studs.

As a general rule, when (as is customary) the studs are set at *16-inch* centers, *1 stud for each foot* in length of partition will be a sufficient allowance to include sills, plates, and double studs. Thus, if the total length of partitions is 75 feet, 75 studs will be sufficient for sills, double studs, etc. If the studs are set at *12-inch* centers, the number required will be equal to the *number of feet in length of partition plus one-fourth*. Thus, if the length of partitions is 72 feet, 72 + 18, or 90, studs will include those required for sills, plates, etc.

The same rules may be used for calculating the number of joists, rafters, tie-beams, etc.

A good way to estimate bridging is to allow 3 cents apiece, or 6 cents per pair; this will be sufficient to furnish and set a pair made of $2'' \times 3''$ spruce or hemlock stuff.

**46. Sheathing.**—To calculate **sheathing** or **rough flooring** (not matched), find the number of feet B. M. required to cover the surface, making no deductions for door or window openings, because what is gained in openings is lost in waste. If the sheathing is laid horizontally, only the actual measurement is necessary; but if it is laid diagonally, add 8 or 10 per cent. to the actual area.

**47. Flooring.**—In estimating **matched flooring**, a square foot of $\frac{7}{8}$-inch stuff is considered to be 1 foot B. M. If the flooring is 3 inches or more in width, add one-quarter to the actual number of board feet, to allow for waste of material in forming the tongue and groove; if less than 3 inches wide, add one-third. Flooring of $1\frac{1}{8}$-inch finished thickness is considered to be $1\frac{1}{4}$ inches thick, and for calculating it the following rule may be used: *Increase the surface measure 50 per cent.* (This consists of 25 per cent. for extra thickness over 1 inch, and 25 per cent. for waste in

tonguing and grooving.) To this amount add 5 per cent. for waste in handling and fitting.

In figuring the area of floors, openings for stairs, fireplaces, etc. should be deducted.

**48. Weather Boarding, or Siding.**—In measuring **weather boarding,** or **siding,** the superficial, or square, foot is usually employed. No deduction should be made for ordinary window or door openings, as these usually balance the waste in cutting and fitting. Careful attention must be given to the allowance for lap. If 6-inch, nominal width (actual width, $5\frac{5}{8}$ inches), siding, laid with 1-inch lap, is used, add one-quarter to the actual area of the space to be covered, in order to obtain the number of square feet of siding required. If 4-inch stuff is used, add one-third to the actual area. When, as previously noted, no allowance is made for openings, the corner and baseboards need not be figured separately.

**49. Cornices.**—As a general rule, **cornices** are measured by the running foot, the molded and plain members being taken separately. A good method of figuring cornices is as follows: *Measure the girth, or outline, and allow* $1\frac{1}{2}$ *cents for each inch of girth, per linear foot.* This price will pay for material and for setting, the cost of the mill work being estimated at 50 per cent.

**50. Cost per Square Foot.**—For all classes of materials that enter into the general framing and covering of a building, a close estimate may be made by analyzing the cost per square foot of surface; that is, the cost of labor and materials—studs and sheathing in walls, joists and flooring in floors, etc.—required for a definite area should be closely determined, and this cost divided by the area considered, will give the price per square foot. If the corresponding whole area is multiplied by the figure thus obtained, the result will, of course, be the cost of that portion of the work. While the usual custom is to adopt a uniform rate for the various grades of work, a careful analysis will show that roof sheathing, where the roof is much cut up, costs more in

place than wall sheathing, owing to its position; also that the studs in walls and partitions cost more than floor joists, as they are lighter and require more handling.

The following example shows how to determine the cost per square foot of flooring and indicates the general method to be pursued in similar cases. The area used in the calculation is a square, or 100 square feet. The cost of labor is estimated at 40 per cent. of that of the materials, as it has been shown by experience that this allowance is a very close approximation to the actual cost of general carpenter work.

Cost of Finished Floor per Square

| | |
|---|---|
| Joists, hemlock, 8 pieces, 3″ × 10″ × 10′, 200 feet B. M., at $27 per M. | $ 5.40 |
| Bridging, hemlock, 7 sets, 2″ × 3″ × 1′ 4″, 9 feet B. M., at $27 per M. | .24 |
| Rough flooring, hemlock, $\frac{7}{8}$ inch thick, laid diagonally, 100 ft. + 25 ft. + 10 ft., 135 feet B. M., at $25 per M. | 3.38 |
| Finished flooring, No. 2, white pine, $\frac{7}{8}$ inch thick, 125 feet B. M., at $45 per M. | 5.63 |
| Nails, eightpenny (about) 3 pounds, at $2.50 per 100 pounds | .08 |
| Labor, 40 per cent. of cost of materials | 5.89 |
| Total cost for 100 square feet | $20.62 |

Cost per square foot, $20.62 ÷ 100 = 21 cents.

A similar method may be followed in estimating the cost of interior finish, paneling, doors, etc.

**51. Work of a Carpenter per Day.**—The quantity of material that a workman can put in place in a day is very uncertain, as it depends on the skill of the man and the ease or difficulty of the work, both being somewhat modified by circumstances. The figures given in Table VI, while founded on information gained by many years of experience, are only intended to give an idea of the relative quantities and are not a standard to be adhered to in all cases. The estimates are based on an 8-hour day and wages at $3.20

## TABLE VI

### QUANTITIES OF MATERIAL PUT IN PLACE PER DAY BY ONE MAN

| Class of Material | Number of Feet B. M., or Number | Remarks |
|---|---|---|
| Studding, $2'' \times 4''$, or $2'' \times 6''$ | 400 | Wall or partition. |
| Rafters | 400 | |
| Rafter ridge and bracing | 250 | |
| Plate, $6'' \times 8''$, halved at corners | 350 | |
| Floor joists, $2'' \times 10''$, or $3'' \times 12''$ | 500 | |
| Ceiling joists, $2'' \times 6''$ | 450 | |
| Sheathing, unmatched | 500 | Laid horizontally. |
| Sheathing, unmatched | 400 | Laid diagonally. |
| Sheathing, matched | 400 | Laid horizontally. |
| Sheathing, matched | 300 | Laid diagonally. |
| Sheathing, roof | 750 | Plain gable roof. |
| Sheathing, roof | 300 | Much cut up by hips, valleys, dormers, etc. |
| Ceiling lined with paper | 200 | |
| Siding, 4 inches wide | 200 | Includes fitting and setting corner boards, base, trim, and scaffolding. |
| Siding, 6 inches wide | 300 | |
| Posts and beams over cellars | 200–250 | Includes scarfing and doweling. |
| Plaster grounds, linear feet | 250 | For base and wainscot, straightened in good shape. |
| Bridging, number of pairs per hour | 10 | Includes cutting and setting. |
| False jambs around openings, per hour | 1 | |

per day. If the hours or pay are less or greater in various localities than the prices given, the results will be correspondingly diminished or increased.

**52. Cost of Laying Flooring.**—The figures on flooring given in Table VII will be found useful in calculating as they are based on a square, which, as previously stated, is equal

TABLE VII

LABOR COST OF LAYING WOODEN FLOORS, ETC.

| Classes of Materials, Etc. | Number of Squares per Man per Day of 8 Hours | Cost per Square at 40 Cents per Hour |
|---|---|---|
| Rough matched hemlock floor, 6 inches wide | 3 | $ 1.07 |
| 3-inch spruce floors laid at right angles to the beams | $3\frac{1}{2}$ | .91 |
| Yellow pine floor with struck joints | $1\frac{1}{2}$ | 2.13 |
| Cypress porch floor, finished with white-lead joints | 1 | 3.20 |
| $\frac{7}{8}$-inch maple floor laid on a plank floor, with paper between; also, struck joints | 2 | 1.60 |
| Laying straight-oak floor | 1 | 3.20 |
| Scraping oak floors | $\frac{1}{3}$ | 9.60 |
| Finishing and waxing oak floors | $\frac{2}{3}$ | 4.80 |
| Parquet floor in 2-inch strips of blocks, $12'' \times 6''$ or $16'' \times 8''$ | $\frac{1}{4}$ | 12.80 |
| Scraping parquet floor | $\frac{1}{4}$ | 12.80 |
| Finishing and waxing parquet floor to good finish | $\frac{2}{3}$ | 4.80 |
| Sleepers, laying and setting, per linear foot | | .02 |

to 100 square feet. The same carpenters' wages and number of working hours as in the preceding article are used here.

**53. Miscellaneous Carpentry Items.**—In Table VIII is given the cost of several items of carpentry, such as setting window and door frames, furring brick walls, etc. The prices are based on the same wages and hours as in the two preceding articles.

TABLE VIII

COST OF MISCELLANEOUS ITEMS OF CARPENTRY

| Class of Work | Cost | Remarks |
|---|---|---|
| Setting window frames in wooden buildings | $ .45 | Each. |
| Furring brick walls, 1″ × 2″ strips, 12-inch centers | .02½ | Per square foot; includes labor, material, and nails. |
| Furring brick walls, 1″ × 2″ strips, 16-inch centers | .01⅞ | Per square foot. |
| Cutting holes and fitting plugs in brick walls | .05 | Each. |
| Setting window frames in brickwork | .60 | Each; includes nails and bracing. |
| Setting door frames in brickwork | .60 | Each. |
| Setting window frames in stonework | 1.25 | Each, for ordinary work. |
| Setting window frames in stonework | 2.00 | Each, for very careful work. |
| Setting door frames in stonework | 2.00 | Each, for very careful work. |
| Furnishing and setting trimmer-arch centers | 2.00 | Each. |
| Arch centers, 4-foot span, 8-inch reveal | 1.50 | Each; includes supports and wedges. |

**54. Nails.**—To calculate the quantity of nails required in executing any portion of the work, Table IX, which is based on the use of cut nails, will be found useful.

TABLE IX

QUANTITY OF NAILS REQUIRED FOR VARIOUS PURPOSES

| Material | Pounds Required | Kind of Nails and Size in Pennies |
|---|---|---|
| 1,000 shingles | 5 | 4 |
| 1,000 laths, 4 nails to a lath | 7 | 3, fine |
| 1,000 laths, 6 nails to a lath | 9 | 3, fine |
| 1,000 sq. ft. beveled siding | 18 | 6 |
| 1,000 sq. ft. sheathing | 20 | 8 |
| 1,000 sq. ft. sheathing | 25 | 10 |
| 1,000 sq. ft. flooring, rough | 30 | 8 |
| 1,000 sq. ft. flooring, rough | 40 | 10 |
| 1,000 sq. ft. studding | 15 | 10 |
| | 5 | 20 |
| 1,000 sq. ft. furring, 1″ × 2″ | 10 | 10 |
| 1,000 sq. ft. $\frac{7}{8}$″ finished flooring | 20 | 8 to 10, finish |
| 1,000 sq. ft. $1\frac{1}{8}$″ finished flooring | 30 | 10, finish |

## ROOFING

**55. Kinds of Roof Covering.**—The **roof coverings** most generally used are shingles, slate, tin, tile, and tarred paper and gravel (known as gravel roofing). While there are slight variations in the methods of measuring the different kinds, they are all based on the square of 100 square feet.

**56. Shingles.**—In measuring **shingle roofing,** it is necessary to know the exposed length of a shingle. This is found by deducting 3 inches (the usual cover over the head of the lowest shingle in the four overlapping courses) from the length and dividing the remainder by 3. Thus, in Fig. 5, the distance *b* that one shingle is overlapped by the third above it is usually made equal to 3 inches, and the remaining length of the lowest shingle may be divided into three equal portions, each equal to *a*. The lowest of these three portions is the part exposed to the weather. Multiplying the length exposed to the weather by the average width of a shingle

will give the exposed area. Dividing 14,400, the number of square inches in a square, by the exposed area of 1 shingle, in square inches, will give the number of shingles required to cover 100 square feet of roof. For example, it is required to compute the number of shingles 18 in. × 4 in. needed to cover 100 square feet of roof. With a shingle of this length, the exposure will be $\frac{18-3}{3} = 5$ inches; then, the exposed area of 1 shingle is 4 in. × 5 in., or 20 square inches, and 1 square requires 14,400 ÷ 20 = 720 shingles.

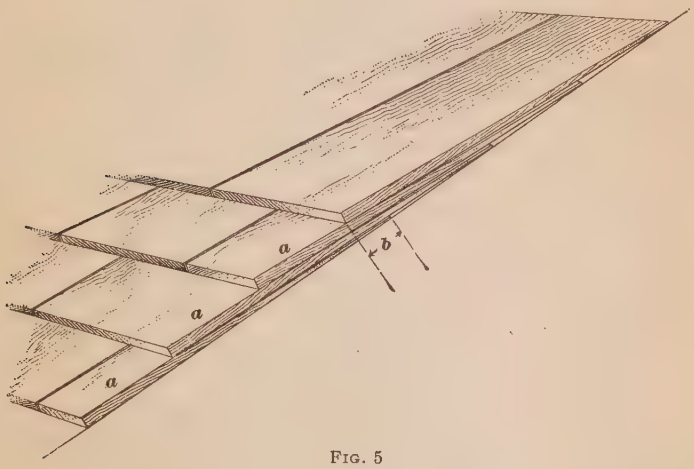



FIG. 5

An allowance should always be made for waste in estimating the number of shingles required.

Table X is arranged for shingles from 15 to 27 inches in length, 4 and 6 inches in width, and for various lengths of exposure.

**57.** Shingles are classed as *shaved*, or *breasted*, and *sawed shingles*.

**Shaved shingles** have fallen almost into disuse, owing to the difficulty of manufacturing them. These shingles vary from 18 to 30 inches in length, and are about $\frac{1}{2}$ inch thick at the butt and $\frac{1}{16}$ inch at the top.

**Sawed shingles** are usually from 14 to 18 inches long and of various thicknesses. In the case of 18-inch shingles, five shingles, at their butts, will make $2\frac{1}{4}$ inches; that is, the thickness of one shingle at the butt is $2\frac{1}{4} \div 5 = .45$, or about $\frac{7}{16}$ inch. At the top, each shingle is $\frac{1}{16}$ inch thick. With 16-inch shingles, however, five of them make only 2 inches. Therefore, the thickness of a 16-inch shingle at the butt is $2 \div 5 = .4$, or about $\frac{3}{8}$, inch.

TABLE X

DATA FOR ESTIMATING SHINGLES

| Exposure to Weather Inches | Number of Square Feet of Roof Covered by 1,000 Shingles | | Number of Shingles Required for 100 Square Feet of Roof | |
|---|---|---|---|---|
| | 4 Inches Wide | 6 Inches Wide | 4 Inches Wide | 6 Inches Wide |
| 4 | 111 | 167 | 900 | 600 |
| 5 | 139 | 208 | 720 | 480 |
| 6 | 167 | 250 | 600 | 400 |
| 7 | 194 | 291 | 514 | 343 |
| 8 | 222 | 333 | 450 | 300 |

White-pine and white-cedar shingles are graded alike. The shingles made of No. 1, or clear, stock are designated XXXX. Those made of No. 2 stock, with 6-inch clear butt, are given the brand XX, while those made of mill cull, with sound butt, are called X.

Red-cedar shingles are graded differently. Their grade depends on their length. Thus, 18-inch, No. 1 shingles are termed "Perfection," while 18-inch, thin butt are termed "Eureka." Red-cedar shingles 16 inches long, if made of No. 1, or clear, stock, are designated "Extra * A *." If they are 16-inch, thin butt, they are termed simply "* A *."

Sawed shingles are made up into bundles of 250, and are sold on a basis of 4 inches width for each shingle. Shingles cost from $4 to $6.75 per thousand, according to material and grade. Dimension shingles—those cut to a uniform

width—if of prime cedar, shaved, $\frac{1}{2}$ inch thick at the butt and $\frac{1}{16}$ inch at the top, will cost about $7.75 per thousand, but since such shingles are usually 6 inches wide, less will be required per square.

A fairly good workman will lay about 1,000 shingles per day of 8 hours, on straight, plain work; while in working around hips and valleys, the average will be about 700 per day.

**58. Slating.**—In measuring **slating,** the method of determining the number of slates required per square is similar to that given for shingling; but in slating, each course overlaps only two of the courses below, instead of three, as in shingling. The usual lap, or cover, of the lowest course of slate by the uppermost of the two overlapping courses, is 3 inches; hence, to find the exposed length, deduct the lap from the length of the slate, and divide the remainder by 2. The exposed area is the width of the slate multiplied by this exposed length, and the number of slates required per square is found by dividing 14,400 by the exposed area of 1 slate in square inches. Thus, if $14'' \times 20''$ slates are to be used, the exposed length will be $\frac{20 - 3}{2} = 8\frac{1}{2}$ inches; the exposed area will be $14 \times 8\frac{1}{2} = 119$ square inches; and the number per square will be $14{,}400 \div 119 = 121$ slates.

The following points should be observed in measuring slating: Eaves, hips, valleys, and cuttings against walls are measured extra, 1 foot wide by their whole length, the extra charge being made for waste of material and the increased labor required in cutting and fitting. Openings less than 3 square feet are not deducted, and all cuttings around them are measured extra. Extra charges are also made for borders, figures, and any change in color of the work; and for steeples, towers, and perpendicular surfaces.

Table XI, which is based on a lap of 3 inches, gives the sizes of the American slates and the number of pieces required per square. The cost of slating varies from 9 to 15 cents per square foot, depending on the class of work.

The thickness of stock slate varies from five to 1 inch to $\frac{3}{8}$ inch and special thicknesses up to 1 inch are made to order. For ordinary dwellings, the usual thickness used is five to 1 inch, which gives a thickness of a little more than $\frac{3}{16}$ inch, and the size used for this class of work is generally 8 in. × 12 in. or 9 in. × 18 in., the price being the same.

TABLE XI

NUMBER OF SLATES PER SQUARE

| Size Inches | Number of Pieces | Size Inches | Number of Pieces | Size Inches | Number of Pieces |
|---|---|---|---|---|---|
| 6 × 12 | 533 | 9 × 16 | 246 | 14 × 20 | 121 |
| 7 × 12 | 457 | 10 × 16 | 221 | 11 × 22 | 138 |
| 8 × 12 | 400 | 9 × 18 | 213 | 12 × 22 | 126 |
| 9 × 12 | 355 | 10 × 18 | 192 | 13 × 22 | 116 |
| 7 × 14 | 374 | 11 × 18 | 174 | 14 × 22 | 108 |
| 8 × 14 | 327 | 12 × 18 | 160 | 12 × 24 | 114 |
| 9 × 14 | 291 | 10 × 20 | 169 | 13 × 24 | 105 |
| 10 × 14 | 261 | 11 × 20 | 154 | 14 × 24 | 98 |
| 8 × 16 | 277 | 12 × 20 | 141 | 16 × 24 | 86 |

In Table XII is given a list of the different colors of slate used in the Eastern and Middle States, the quarries from which they are obtained, and the cost of slate, labor, etc. per square, pertaining to each variety. The prices in the table are based on the 8 in. × 12 in. or 9 in. × 18 in. sizes, thickness five to 1 inch, and for quantities of not less than 50 squares. The cost of labor, etc. being based on current prices in the aforementioned territory.

Slate $\frac{1}{4}$ inch thick cost about 20 per cent. more than the five to 1 inch for the material, and about 5 per cent. more for laying and freight.

Slate $\frac{3}{8}$ inch thick cost about 45 per cent. more than the five to 1 inch for the material, and about 15 per cent. more for laying and freight.

When copper nails are specified obtain current prices.

TABLE XII

APPROXIMATE COST OF SLATING, PER SQUARE

| Classification | Cost of Slate F. O. B. Quarries | Cost of Laying, Including Roofing Felt, and Freight | Total Cost, Exclusive of Builder's Profit |
|---|---|---|---|
| *Black Slate* | | | |
| Brownville, Maine | $8.00 | $5.00 | $13.00 |
| Monson, Maine | 7.00 | 5.00 | 12.00 |
| Peach Bottom, Pennsylvania | 5.50 | 4.00 | 9.50 |
| Chapman (Hard Vein), Pennsylvania | 4.50 | 3.50 | 8.00 |
| Bangor, Pennsylvania | 4.50 | 3.50 | 8.00 |
| Lehigh, Pennsylvania | 4.00 | 3.50 | 7.50 |
| Buckingham, Virginia | 3.75 | 4.00 | 7.75 |
| *Red Slate* | | | |
| Vermont | 12.00 | 4.25 | 16.25 |
| *Green Slate* | | | |
| Vermont | 5.50 | 4.25 | 9.75 |
| *Purple Slate* | | | |
| Vermont | 5.00 | 4.25 | 9.25 |
| *Mottled Slate* | | | |
| Vermont (Purple and Green) | 4.00 | 4.25 | 8.25 |

**59. Sheet-Metal Roofs.**—In estimating sheet-metal roofs, the hips and valleys are measured extra their entire length by 1 foot in width, to compensate for increased labor and waste of material in cutting and laying. Gutters and conductor pipes, or leaders, are measured by the linear foot, 1 foot extra being added for each angle. All flashings and crestings are measured by the linear foot. No deductions are made for openings (chimneys, skylights, ventilators, or dormer-windows) if they are less than 50 square feet in area; if between 50 and 100 square feet, one-half the area is deducted; if over 100 square feet, the whole opening is

deducted. An extra charge is made for labor and waste of material to flash around openings.

**60.** There are two regular sizes of roofing plates, namely, 20 in. × 28 in. and 14 in. × 20 in. The larger size is generally used on common work, owing to the fact that it requires fewer seams on the roof and consequently cheapens the cost of laying. A third size, namely, 10 in. × 20 in., is also supplied, and is used generally for gutters and leader pipes. Sheets 10 in. × 14 in. are sometimes used for laying roofs, as they can be cleated better than the larger sizes. Such small sheets, however, cost more to lay.

Two thicknesses of roofing plates are commonly recognized. One is the IC, or No. 29 gauge, and weighs 8 ounces to the square foot; the other is the IX, or No. 27 gauge, and weighs 10 ounces to the square foot. Sometimes, a still heavier plate is called for, and it is therefore kept in stock by the best manufacturers. This plate is known as IXX, or No. 26 gauge, and is used for especially heavy work.

Formerly, the standard net weight per box of IC, 14″ × 20″ roofing tin was 112 pounds, or 1 pound per sheet, making 112 sheets to the box; but now this weight is reduced to 108 pounds. The old standard for IX plates was 140 pounds, but very few brands now weigh more than 135 pounds per box. The most reliable manufacturers guarantee the weights for the different boxes of tin, and if the material does not come up to the guaranteed weight, it can be returned. The best sheets in the market today are stamped with the mark of the brand and the designation IC or IX of the thickness.

**61.** Using standing joints, a 14″ × 20″ sheet of roofing tin will cover about 235 square inches of surface, or one box of such tin will cover about 182 square feet. With a flat, lock seam, a sheet will cover 255 square inches, allowing $\frac{3}{8}$ inch all around for joints; or a box will lay 198 square feet. These figures make no allowance for waste.

Two good workmen can put on from 250 to 300 square feet of tin roofing per day of 8 hours; this also includes painting the outside of the tin. Tin roofing will cost from

8 to 10 cents per square foot, depending on the quality of material and workmanship.

**62. Tile Roofs.**—Since **tile roofs** are constructed of so many styles of tile, no general rules of measurement can be given. Every piece of work must be estimated according to the particular kind of tile used and the number of sizes and patterns. Information on all these points is to be found in the catalogs of tile manufacturers.

TABLE XIII

APPROXIMATE COST OF ROOF TILING, PER SQUARE

| Classification | Cost of Tile Delivered | Cost of Laying Including Asphalt Felt | Total Cost Exclusive of Builder's Profit |
|---|---|---|---|
| Shingle tile (rectangular), 6″ × 12″ . | $13.00 | $ 7.50 | $20.50 |
| Shingle tile (rectangular), 8″ × 12″ . | 14.00 | 6.50 | 20.50 |
| Shingle tile (geometric shapes) . . | 12.00 | 7.00 | 19.00 |
| Conosera (interlocking), 8″ × 12″ . . | 14.00 | 5.50 | 19.50 |
| Conosera (interlocking), 10″ × 15″ . | 12.00 | 5.00 | 17.00 |
| Conosera, combination 8″ × 12″ and 2″ × 12″ . . . . . | 16.50 | 8.00 | 24.50 |
| French A (interlocking), size 10″ × 15″ | 12.00 | 5.00 | 17.00 |
| Spanish, 8″ × 12″ . . . . . | 13.00 | 6.50 | 19.50 |
| Old Spanish, semicircular, channels laid alternately, concave and convex . . . . . | 22.50 | 10.00 | 32.50 |
| Roman, pan and semicircular roll, laid 7½ in. center to center of rolls | 17.00 | 8.00 | 25.00 |
| Greek, pan and semihexagonal cap, laid 7½ in. center to center of caps | 17.00 | 8.00 | 25.00 |
| Promenade for flat roofs, laid on 5 layers of asphalt felt in asphalt pitch . . . . . | 7.00 | 13.00 | 20.00 |

In Table XIII is given a list of the prevailing styles of roof tiling, the cost of tiling, labor, etc. per square, pertaining to each variety. The prices in the table are based on the natural red color of the clay when burnt; extra prices are asked for glazed-surface finish which can be obtained in different colors. The prices in the table are based on

quantities of not less than 30 squares, as less than a minimum carload means increased freight rates. The prices given cover railroad delivery to points in the Eastern and Middle States. Labor, etc. being based on current prices.

The above prices are figured on the tile being laid on wooden sheathing; if laid on book tile or cement add 20 per cent.

If copper nails are used, care must be taken in figuring the number of nails, as well as their length and gauge, for the special forms of tile specified. Fluctuating values of copper make this an item of much importance.

Ridges, hip rolls, barge tile, and finials are charged as extras and due allowance must be made for cutting at valleys and hips.

**63. Gravel Roofs.**—In **gravel roofing,** the cost per square depends on the number of thicknesses of tarred felt and the quantity of pitch used per square. A value of 4 cents per square foot for four thicknesses may be considered an average.

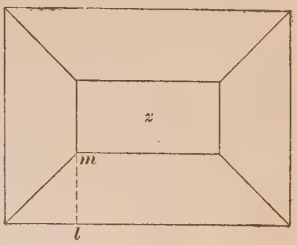
### ROOF MENSURATION

**64.** While a knowledge of how to apply the ordinary principles of mensuration is all that is necessary to calculate any roof area, yet the modern house, with its numerous gables and irregular surfaces, introduces complications that render some further explanation of roof measurement desir-

FIG. 6

able. The most common error made in figuring roofs—and one that should be carefully guarded against—is that of using the apparent length of slopes, as shown by the plan or side elevations, instead of the true length, as obtained from the end elevations.

**65.** The area of a plain gable roof, as shown in end and side elevations in Fig. 6, is found by multiplying the length *g j* by the slope length *b d*, and further multiplying by 2, for both sides. The area of each gable is found by multiplying the width of the gable *a d* by the altitude *c b*, and dividing by 2.




**66.** In Fig. 7 is shown the plan and elevation of a hip roof, having a deck *z*. The pitch of the roof being the same on each side, the line *c d* shows the true length of the common rafter *l m*.

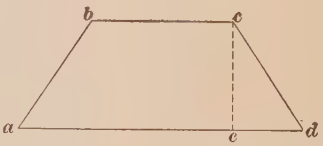



Fig. 7

In Fig. 8 is shown the method of developing the true lengths of the hips and the true size of one side of the roof.

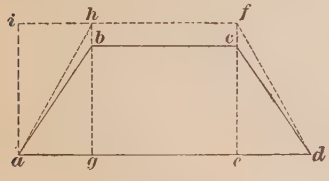



Fig. 8

Let *a b c d* represent the same lines as the corresponding ones in Fig. 7. From the line *a d*, Fig. 8, through *b* and *c*, draw perpendiculars, as *g h* and *e f*; lay off from *g* and *e* on these lines, the length of the common rafter *c d*, Fig. 7, and draw the lines *a h* and *d f*, Fig. 8; then the figure *a h f d* will represent the true shape and size of the side of the roof shown in the elevation in Fig. 7. The area of the triangle *d e f* is equal to the area of the triangle *a g h* or a similar triangle *a i h*. Hence, the portion of the roof *a h f d* is equal in area to the rectangle *a i f e*, the length of which is half the sum of the eave and deck lengths, while its breadth is the length of a common rafter.

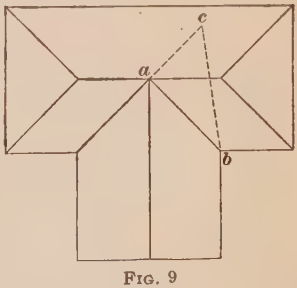



Fig. 9

**67.** A method of obtaining the lengths of valley rafters, applicable also to hip rafters, is shown in Fig. 9, which is the plan of a hip-and-gable roof. To ascertain the length of the valley rafter *a b*, draw the line *a c* perpendicular to *a b* and equal in length to the altitude of the gable; then draw

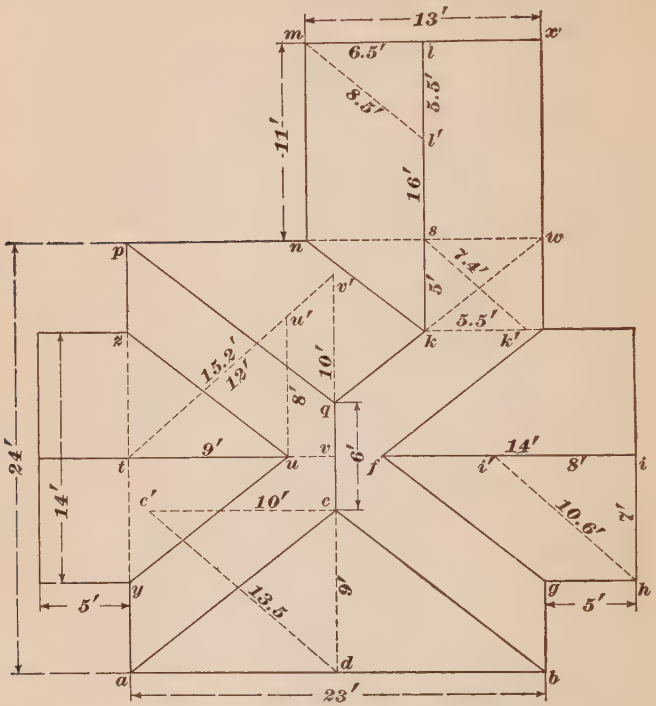



Fig. 10

the line *c b*, which will represent the true length of the valley rafter *a b*.

**68.** As an example of roof mensuration, the number of square feet of surface on the roof shown in Fig. 10 will be calculated.

The area of the triangular portion *a c b* is equal to the slope length of *d c* (found by laying off *c′ c* equal to the height of the ridge above the eaves and drawing *c′ d*)

multiplied by the length of the eaves line $a\,b$ and divided by 2. Multiplying the dimensions 13.5 feet and 23 feet, respectively, and dividing by 2, the area is found to be 155.3 square feet.

The area of the trapezoid $g\,f\,i\,h$ is half the sum of $f\,i$ and $g\,h$ (shown in their true length on the plan) multiplied by the true length of $h\,i$. The latter is found by marking the height of the gable $i\,i'$ on the ridge line, and drawing the line $i'\,h$, which measures 10.6 feet. Performing these operations, there results $\frac{5+14}{2} \times 10.6 = 100.7$ square feet for each side, or 201.4 square feet for both. As each of the side gables is the same size, the area of the two roofs is $201.4 \times 2 = 402.8$ square feet.

The area of the polygon $q\,p\,n\,k$ is equal to the triangle $q\,p\,w$ minus the triangle $k\,n\,w$, the area covered by the intersecting gable roof. The former is equal to the triangle $a\,c\,b$, the area of which is 155.3 square feet. The area of $k\,n\,w$ is equal to half of $n\,w$, or 6.5 feet, multiplied by the true length of $k\,s$ or the altitude of the triangle; the latter is obtained by laying off $k\,k'$ equal to the height of the gable, 5.5 feet, at right angles to $k\,s$, and drawing $s\,k'$, which is the required altitude and which measures almost 7.4 feet. Then $k\,n\,w = 6.5 \times 7.4 = 48.1$ square feet; whence $q\,p\,n\,k$ equals $155.3 - 48.1 = 107.2$ square feet.

The area of $a\,p\,q\,c$ is $\frac{a\,p + q\,c}{2}$ multiplied by the true slope length of $t\,v$, or $t\,v'$, which measures 15.2 feet. Substituting dimensions, the area is found to be $\frac{6+24}{2} \times 15.2 = 228$ square feet. From this deduct the area of $y\,z\,u$, which is the portion covered by the intersecting gable roof. The true length of $t\,u$ along the slope is $t\,u'$, measuring 12 feet; hence, the area of $y\,z\,u$ is $\frac{14 \times 12}{2} = 84$ square feet. The net area of $a\,p\,q\,c$ is therefore $228 - 84 = 144$ square feet; $b\,c\,q\,w$ being equal to $a\,p\,q\,c$, its area is the same, making the area of both sides 288 square feet.

The area of $k\,n\,m\,l$ is $\frac{m\,n + l\,k}{2} \times m\,l'$, the slope length of $m\,l$. Substituting dimensions, the area is $\frac{11 + 16}{2} \times 8.5$ = 114.8 square feet. As $k\,l \times w$ is equal to $k\,n\,m\,l$, the area of both is 229.6 square feet.

Adding the partial areas thus obtained, the sum is 155.3 + 402.8 + 107.2 + 288 + 229.6 = 1,182.9 square feet, or approximately 11.9 squares.

## PLASTERING

**69. Plastering** on plain surfaces, such as walls and ceilings, is always measured by the square yard. In determining the cost of plastering walls and ceilings, measure the surface actually plastered, making no deduction for grounds or for openings less than 7 superficial yards. For surfaces of domes or groined ceilings, beams, coves, paneling, etc., a unit price is fixed by the linear or the superficial foot, according to the character and disposition of the work. Round corners and arrises should be measured by the linear foot.

On interior work, increase the price 5 per cent. for each 12 feet above the floor after the first. For outside work, add 1 per cent. for each foot above the lower 20 feet. All repairing and patching should be done at agreed prices.

**70. Stucco Work.**—In estimating **stucco work**, cornices composed of plain members and panel work are measured by the square foot. Enriched cornices with carved moldings are measured by the linear foot. When moldings are less than 12 inches in circumference, measurement is taken by the linear foot; when over 12 inches, superficial measurement is used. For internal angles or miters, add 1 foot to the length of cornice, and for exterior angles add 2 feet to the length. Sections of cornice less than 12 inches measure as 12 inches. Add one-half for raking cornices.

For cornices or moldings abutted against a wall or plain surface, add 1 foot to the length of cornice; if against the soffit of stairs or other inclined or covered surface, add 2 feet

to the length of cornice. Octagonal, hexagonal, and similar cornices, less than 10 feet in single stretches, take one and one-half times the length.

For circular or elliptical work, charge double price; for domes and groins, three prices. Enrichments of all kinds should be estimated at an agreed price.

**71. Cost of Plastering.**—The following analysis of the cost of plastering for 100 square yards, for both three-coat and two-coat work, will be of assistance in making estimates. These costs are exclusive of the lathing, which will be taken up later.

COST OF 100 SQUARE YARDS OF THREE-COAT PLASTERING

*Scratch Coat*

| | |
|---|---|
| 6 bushels of lime, at 25 cents per bushel | $ 1.50 |
| 9 pounds of hair, at 4 cents per pound | .36 |
| ¾ cubic yard of sand, at $1.50 per cubic yard | 1.13 |
| 5 hours, plasterer's time, at 50 cents per hour | 2.50 |
| 5 hours, laborer's time, at 25 cents per hour | 1.25 |
| Total | $ 6.74 |

*Brown Coat*

| | |
|---|---|
| 6 bushels of lime, at 25 cents per bushel | $ 1.50 |
| 3 pounds of hair, at 4 cents per pound | .12 |
| 1 cubic yard of sand, at $1.50 per cubic yard | 1.50 |
| 13 hours, plasterer's time, at 50 cents per hour | 6.50 |
| 6½ hours, laborer's time, at 25 cents per hour | 1.63 |
| Total | $11.25 |

*Finishing Coat*

| | |
|---|---|
| 3½ bushels of finishing lime, at 35 cents per bushel | $ 1.23 |
| ½ barrel of plaster of Paris, at $1.75 per barrel | .88 |
| ⅜ bushel of white sand, at 27 cents per bushel | .10 |
| 18 hours, plasterer's time, at 50 cents per hour | 9.00 |
| 4½ hours, laborer's time, at 25 cents per hour | 1.13 |
| Total | $12.34 |

The total cost of 100 square yards of three-coat plaster, then, is $30.33, or about 31 cents per yard.

Cost of 100 Square Yards of Two-Coat Plastering

*Brown Coat*

| | |
|---|---|
| 8 bushels of lime, at 25 cents per bushel | $ 2.00 |
| 16 pounds of hair, at 4 cents per pound | .64 |
| $1\frac{1}{4}$ cubic yards of sand, at $1.50 per cubic yard | 1.88 |
| 8 hours, plasterer's time, at 50 cents per hour | 4.00 |
| 8 hours, laborer's time, at 25 cents per hour | 2.00 |
| Total | $10.52 |

*Finishing Coat*

| | |
|---|---|
| Same as given for three-coat work | $12.34 |

The total cost of 100 square yards of two-coat plaster is therefore $22.86, or about 23 cents per square yard.

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LATHING

**72. Lathing** is measured by the superficial, or square, yard, no openings under 7 superficial yards being deducted.

Plastering laths are about $1\frac{3}{4}$ inches wide, $\frac{1}{4}$ inch thick, and usually 4 feet long, the studding being generally placed 12 or 16 inches on centers, so that the ends of the laths may be nailed to them. The laths are usually set from $\frac{1}{4}$ to $\frac{3}{8}$ inch apart, requiring about $1\frac{1}{2}$, $1\frac{7}{16}$, or $1\frac{3}{8}$ four-foot laths, respectively, to cover 1 square foot.

For a fair grade of work, a man will lay on an average about 15 bundles, or 1,500 laths, per day. The price usually paid for laying laths is 25 cents a bundle.

In the following analysis is given the cost of lathing 100 square yards of surface:

Cost of Lathing 100 Square Yards

| | |
|---|---|
| $14\frac{4}{10}$ bundles of laths, at 55 cents per bundle | $ 7.92 |
| 9 pounds of threepenny nails, at $3.65 per hundred pounds | .33 |
| Putting on $14\frac{4}{10}$ bundles, at 25 cents per bundle | 3.60 |
| Total | $11.85 |

The total cost of lathing 100 square yards is therefore $11.85, or about 12 cents per square yard.

## JOINERY

**73.** **Joinery** includes all the interior and exterior finish put in place after the framing and covering are completed; as, for example, door and window frames, doors, baseboards, paneling, wainscoting, stairs, etc. Most of these materials are worked at the mill and are brought to the building ready to set in place.

**74.** **Frames.**—In taking off **door** and **window frames,** describe and state sizes. Measure architraves by the running foot, giving width and thickness, whether molded or plain, and state the number of plinth and corner blocks.

**75.** **Sash.**—For **sash,** state dimensions (giving the width first); thickness of the material, molded or plain; style of check-rail and sill finish; thickness of sash bar; whether plain, single or double hung; and sizes (giving dimensions in inches) and number of lights. Use standard sizes as much as possible.

**76.** **Doors.**—In taking off **doors,** describe and state the sizes and thicknesses, whether the framing is stuck-molded, raised-molded, or plain; and number of panels, whether plain or raised. Use stock sizes wherever possible and suitable. For special work, where doors are to be veneered, state thickness of veneer, how cores are to be built, and the kind of wood to be used.

**77.** **Blinds.**—Describe size and thickness of **blinds;** whether paneled or slatted (fixed or movable), and whether molded or plain.

**78.** **Baseboard and Beam Casings.**—Measure the **baseboard** and **beam casings** by the running foot, stating width and thickness of stuff, and whether molded or plain. When a shoe is used for the base, so state; also, if a surbase is required, give particulars.

**79.** **Wainscoting.**—Measure **wainscoting** by the superficial foot. State kind of finish, whether paneled or

plain, and style of molding and panels. Wainscoting cap and base, measure by the running foot.

**80. Stairways.**—Often **stairways** are taken by the contractor at so much per step, complete according to specifications. In measuring stairways, take off the amount of rough material in carriage timbers, and the planed lumber in treads, etc. Measure balustrades by the linear foot. Give description of newels. Measure spandrel and stairway paneling the same as wainscoting.

**81. Inside Fixtures.**—*Kitchen dressers* may be taken at a fixed price complete; or at a fixed rate per square foot; or as dressed lumber, drawers and doors being taken separately. *Wardrobes*, *bookcases*, *mantels*, and *china closets* should be treated separately, and a fixed price stated.

**82. Porches, Etc.**—*Porches*, *exterior balustrades*, *balconies*, *porte cochères*, etc. may be taken at a price per linear foot, or the actual quantity of material may be measured.

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### JOINERY DATA AND EXAMPLES OF ESTIMATING COSTS

**83. Molding.**—Molded work that goes through the mill is usually charged for by the square inch of section per foot in length. Thus, if the price is 1 cent per square inch of section per foot in length, a molding $\frac{7}{8}$ in. $\times$ $4\frac{3}{4}$ in. and 12 feet long will cost 60 cents, because the section in the rough is 1 in. $\times$ 5 in., or 5 square inches. Therefore, 1 foot of this molding will cost 5 cents, and 12 feet will cost 60 cents. This method of charging for molding, however, is not altogether satisfactory, because it requires as much time to put a narrow piece of molding through the molding machine as it does a wide piece, and a wide piece, since it will have a larger sectional area, will bring a higher price.

A molding machine operates at different speeds, being run at a slow speed when cutting hard woods and at a high speed when cutting soft woods. A machine will turn out from 900 to 4,800 linear feet of molding of any width per hour, the 900 feet representing the amount of very hard

wood run through the machine, and the 4,800 feet the amount of soft wood run through when the machine is speeded up to its full capacity. The average output of a machine, however, is about 3,000 feet per hour.

The cost of the machine with a man to operate it may be considered as 70 cents an hour on an average, the man getting 30 cents per hour and the machine being charged for at the rate of 40 cents per hour. Therefore, according to these figures, the cost of machining per linear foot is only $\frac{70}{3000}$, or .023 of 1 cent. It will thus be seen that the actual cost of putting molding through the machine, especially in large quantities, does not amount to much.

For this reason, especially in the eastern cities, it is cheaper to buy molding direct from the lumber mill than to buy the rough material and then run it through the mill at its destination. In nearly every instance the saving effected in putting the rough material through the machine at its destination is more than counterbalanced by the extra cost of freight rates due to the extra weight. For the same reason, in the eastern market today planed boards are really as cheap as rough ones, because the planed boards are lighter and thus cost less freight.

The cost of molding is governed almost entirely by the cost of the raw material, and is always reckoned from a base price of 1 cent per square inch of section 1 foot long. On this price a discount is given, depending on the kind of wood and the finish desired. At present an average discount for soft woods, such as white pine, spruce, cypress, etc., is about 35 per cent. Thus, the actual cost of pine molding 1 foot long and 1 square inch in cross-section is $1 - \frac{35}{100} = \frac{65}{100}$ of 1 cent. No discount is given on hard woods in many of the large eastern cities at present—oak, birch, and the like being figured net. For walnut, mahogany, and other high-priced woods, a special price is set, depending on the market and the local prices.

**84. Cost of Window Frames and Windows.**—The following is approximately the cost of a window frame with

two $28'' \times 28''$ lights, where all mill work is priced at $\frac{65}{100}$ cent per square inch per foot:

Cost of Window Frame

| | |
|---|---|
| Jambs at head, $\frac{5}{4}'' \times 5'' \times 16'$ | $ .65 |
| Sill, $2'' \times 5'' \times 4'\ 0''$ | .26 |
| Sub-sill, $\frac{5}{4}'' \times 6'' \times 2'\ 9''$ | .14 |
| Blind stop, $1'' \times 2'' \times 16'\ 0''$ | .21 |
| Parting stop, $\frac{1}{2}'' \times 1'' \times 16'\ 0''$ | .11 |
| Outside casing, $\frac{5}{4}'' \times 5'' \times 12'\ 0''$ | .49 |
| Head casing, $\frac{5}{4}'' \times 7'' \times 4'\ 0''$ | .23 |
| Rabbeted cap, $\frac{5}{4}'' \times 4'' \times 4'\ 0''$ | .13 |
| Molding under cap, $1'' \times 3\frac{1}{2}'' \times 4'\ 6''$ | .11 |
| Sill nosing, $\frac{5}{4}'' \times 4'' \times 4'\ 0''$ | .13 |
| Inside casing, including apron, $1'' \times 5'' \times 20'\ 0''$ | .65 |
| Back band, $\frac{5}{4}'' \times \frac{5}{4}'' \times 16'\ 0''$ | .17 |
| Inside stops, $\frac{1}{2}'' \times 2'' \times 14'\ 0''$ | .10 |
| Four sash pulleys, at 3 cents per pulley | .12 |
| Making frame, 1 hour, at 40 cents per hour | .40 |
| Total | $3.90 |

The cost of setting and casing such a window frame is about 70 cents. The total cost of the frame set in place is therefore $\$3.90 + .70 = \$4.60$.

The cost of the frame per square foot of light is therefore

$$\frac{\$4.60 \times 144}{2 \times 28 \times 28} = 43 \text{ cents}$$

**85.** The cost of an ordinary window with two $28'' \times 28''$ lights may be estimated as follows:

Cost of Sash in Place

| | |
|---|---|
| Cost of two sash, $\frac{6}{4}$, double hung, glazed with single-thick American glass | $2.10 |
| Sash weights, 30 pounds, at 2 cents per pound | .60 |
| Cord, $22\frac{1}{2}$ feet, at 1 cent per foot | .23 |
| Two sash lifts, at 5 cents each | .10 |
| Sash lock | .15 |
| Setting and hanging sash | .35 |
| Total | $3.53 |

If double American instead of single American glass is used, the cost just given should be increased by $1.

If the sash is glazed with single American glass, the cost per square foot of light will be $\frac{\$3.53 \times 144}{2 \times 28 \times 28} = 33$ cents. Therefore, the total cost of window and frame in place is $43 + 33 = 76$ cents per square foot. If the sash is glazed with double American glass, the cost per square foot of light will be $\frac{\$4.53 \times 144}{2 \times 28 \times 28} = 42$ cents. Therefore, in this case the total cost of window and frame will be $43 + 42 = 85$ cents per square foot.

For curved sash in curved walls, the cost is about twice as much as that of straight work.

**86. Cost of Door Frames and Doors.**—The following estimate represents the cost of an ordinary door frame. All molded work is put in the estimate at 1 cent per square inch of section per foot of length less 35-per-cent. discount, which is the same thing as $\frac{65}{100}$ cent per square inch of section per foot.

COST OF A 2′ 8″ × 6′ 8″ DOOR FRAME IN PLACE

| | |
|---|---|
| 17 linear feet of $\frac{5}{4}$″ × 6″ rabbeted jambs | $ .83 |
| 36 linear feet of 1″ × 5″ casing | 1.17 |
| 36 linear feet of 1″ × 2″ back band | .47 |
| Dadoing and smoothing jambs and casing, 1 hour, at 40 cents per hour | .40 |
| Nails | .05 |
| Setting up jambs and casing, 3 hours, at 40 cents per hour | 1.20 |
| Total | $4.12 |

The area of the door is 2 ft. 8 in. × 6 ft. 8 in. = 17.78 square feet. Therefore, the cost of the preceding door frame per square foot of door is $4.12 ÷ 17.78 = 23 cents.

**87.** The following estimate gives the cost of a door of moderate price. The size of this door is 2 ft. 8 in. × 6 ft. 8 in. × $\frac{6}{4}$ in. It has four panels, is made of No. 1 pine, and is finished with solid ogee molding.

Cost of Door in Place

| | |
|---|---|
| Price of door | $2.75 |
| Setting door, putting on hinges and lock, 2 hours, at 40 cents per hour | .80 |
| 1 pair of 4″ × 4″ japanned-steel butts | .16 |
| 1 mortise lock, brass-face knobs and escutcheons | .70 |
| Total | $4.41 |

If the door is provided with stuck molding instead of solid molding, it will cost about 50 cents more.

The area of the door is 2 ft. 8 in. × 6 ft. 8 in. = 17.78 square feet. The cost per square foot is therefore $4.41 ÷ 17.78 = 25 cents. The total cost of door and frame per square foot of door is therefore 25 + 23 = 48 cents.

**88.** The door just described has no transom. A transom 2 ft. 8 in. × 16 in., complete, will cost about $1. The area of such a transom is 2 ft. 8 in. × 16 in. = $3\frac{5}{9}$ square feet. The cost per square foot is therefore $1 ÷ $3\frac{5}{9}$ = 28 cents.

The prices just given are for solid pine doors. Veneered hardwood doors are usually made to order. When the contractor bids on a house, the architect as a rule has not yet detailed the veneered doors; therefore, the contractor is more or less uncertain as to what will be required and usually puts in a price that he thinks will cover the cost. In the eastern part of the United States, for a veneered door, with $\frac{1}{4}$-inch veneers built of staved-up cores, a price of from 35 to 50 cents per square foot will be found adequate. This price does not of course include the frame.

**89.** There is now on the market a ready-made, veneered birch door known as the *Korelock door*. In using these doors, it is always cheaper to make the door frame of the correct size to take stock-size doors. The price of these doors is quite reasonable. For a 2′ 8″ × 6′ 8″ × $\frac{6}{4}$″ door, with six cross-panels, the price is $2.80 for $\frac{1}{8}$-inch veneer; if the door is $\frac{7}{4}$ instead of $\frac{6}{4}$ inch, the price is $3.25. This price of course includes no hardware or frame. A 2′ 8″ × 6′ 8″ × $\frac{6}{4}$″ two-panel door costs $3.30, and if $\frac{7}{4}$ inch, it costs $3.75.

A 2′ 8″ × 6′ 8″ × 1⅜″, half-glass door, with plain glass, costs $5.55; with art or lace glass, the price is $6.20. This price includes the glass. If the door is 1¾ inches thick instead of 1⅜ inches, 65 cents should be added to the two prices just stated.

A fair workman can hang, trim, and put hardware, including mortise lock, on about four ordinary doors per day. For veneered doors, or those requiring extra care, not more than two can be put in place in a day by one man.

**90. Cost of Baseboards, Rails, and Moldings.**—The cost of material and fitting in place of baseboards may be estimated at $1\frac{3}{10}$ cents per square inch of section per linear foot. This price is for pine; if hardwood is used, the price will be 2 cents. The same rule also applies to chair rails, cap rails, and natural-finish picture moldings.

**91. Cost of Paneling and Wainscoting.**—Paneling may be estimated at 20 cents per square foot for ⅞-inch pine; if over ⅞ inch, add simply for extra material. If the paneling is of hardwood and veneered, add 50 per cent. to the price of pine.

Plain wainscoting may be estimated at 9 cents per square foot, the cap being figured separately by the linear foot.

**92. Cost of Stairs.**—The cost per step for an ordinary stairway, constructed according to the following specifications, is about $3.55. For a better class of work, about one-quarter should be added to this price. Length of steps, 3 feet; tread, Georgia pine; riser, white pine; open string, white pine; nosing and cove; dovetail balusters, square or turned; rail 2½ in. × 3 in.; 6-inch start newel, cherry; two 4-inch square angle newels, with trimmed caps and pendants; simple easements, furred underneath for plastering; treads and risers tongued together, housed into wall strings, wedged, glued, and blocked.

The material of such a stairway will cost about $1.84 per step. This rate includes landing fascia and balustrade to finish on upper floor. The labor on the same, mill work and setting in place, is about $1.71 per step. For example, for

a stairs having 17 steps and landing balustrade (including return, about 14 feet), the entire cost will be 17 × $3.55 = $60.35, of which $31.28 will represent the cost of dressed lumber, including turned balusters and newels and worked rail, and $29.07 will represent the cost of labor in housing strings, cutting, mitering, and dovetailing steps, working easements, fitting and bolting rail, and erecting stairway in building.

**93. Cost of Verandas.**—For small dwellings, it has been found by experience that a veranda built according to the following specifications will cost about $3.75 per linear foot: Width, 5 feet; posts, turned, set 6 or 8 feet on centers; floor timbers, 2 in. × 6 in.; flooring, $\frac{7}{8}$-inch white pine, sound grade; rafters, 2 in. × 4 in., dressed; purlins, 2 in. × 4 in., set 2 feet on centers; roof sheathing, $\frac{7}{8}$-inch white pine; box frieze and angle mold; angle and face brackets; steps; no balustrade.

To include balustrade with 2-inch turned balusters, add about 60 cents per linear foot.

For a veranda built according to the following specifications, the cost will be about $6.75 per linear foot: Width, 8 feet; columns, 9-inch, turned; box pedestals; box cornice and gutter; level ceiling; roof timbers, 2 in. × 6 in.; roof covered with matched boards; tin, a good grade; floor timbers, 2 in. × 8 in.; floor, $1\frac{1}{4}$-inch white pine, second grade, with white-lead joints; no balustrade.

Including balustrade, with $2\frac{1}{2}$-inch turned balusters, rail, and base to suit, add 80 cents per linear foot.

Where a portion of the veranda is segmental or semi-circular, a close approximation to the cost will be had if the circumference of the circular part is measured, and a rate fixed at twice that for straight work of the same length. This applies to veranda framing, roofing, casing, and balustrades.

### STRUCTURAL STEEL

**94.** The price of **structural steel** varies continually as the steel market fluctuates. The cost of erecting steel also varies continually and depends on the difficulties to be overcome. Heavy steel work costs less per pound than light roof trusses and domes, because less shop work is required in proportion to the weight. For average prices in the eastern part of the United States, heavy steel may be taken at $3\frac{3}{10}$ cents per pound. Roof trusses, due to extra framing, will cost about $3\frac{8}{10}$ cents per pound, and light, complicated dome work will cost $6\frac{1}{2}$ cents per pound. These prices are for steel delivered and painted. To erect steel costs anywhere from $\frac{1}{2}$ to 2 cents per pound, depending on local conditions.

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### HEATING AND VENTILATING SYSTEM

**95.** **Heating** and **ventilating work** should be estimated as indicated in the following paragraphs:

Estimate all pipes and fittings the same as for plumbing. Sum up all standard radiators, and the price per square foot of radiation. Figure special radiators separately.

Itemize all valves, air vents, hangers, etc.

Estimate on pipe coverings by linear foot.

Estimate sheet-metal, indirect-radiator casings in pounds.

Estimate sheet-metal flues and smoke pipes by the linear foot; but estimate elbows and dampers separately.

Estimate register boxes, registers, and borders separately.

Make separate items of expansion tanks, hot-water damper regulators, and furnace regulators.

Figure heaters, steam boilers, and furnaces from manufacturers' catalogs.

In estimating on heating by furnace, the average cost of labor is about one-third that of materials. For steam and hot-water heating, the ratio is about one-fifth.

The cost of a hot-air installation is approximately 6 per cent. of the cost of the building; for steam heating, 8 per cent.; and for hot-water heating, 10 per cent.

## PLUMBING AND GAS-FITTING

### PLUMBING

**96.** An approximate figure for the cost of **plumbing** is 10 per cent. of the cost of the building. This figure is for good materials and labor, and of course is subject to considerable variation. The cost of labor alone will average about one-fourth the cost of the materials.

**97. Drainage System.**—In making estimates for the **drainage system,** measure all horizontal pipes from the plans and all vertical pipes from the sectional drawings.

Commence at the sewer outlet and measure the main-sewer line forwards into the building; then measure the horizontal branches.

Measure the vertical, soil, waste, and vent stacks to their terminations above the roof, and waste-pipe branches to the fixtures on the several floors.

Itemize the several pipes in the different kinds and classes.

Estimate all earthen pipe by the linear foot, allowing for Portland cement in the joints.

Estimate all cast-iron pipe by the linear foot, allowing for each joint $\frac{3}{4}$ pound of lead for every inch in diameter of the pipe.

Estimate wrought pipe by the linear foot, inclusive of couplings.

Estimate brass, copper, and lead pipe by the pound.

Estimate all traps, bends, branches, increasers, reducers, and other fittings separately, except such special brass fixtures, traps, and connections as are included in the cost of the fixtures. Do not figure lead bends that are smaller than 2 inches.

Estimate on brass-ferrule connections at all points where lead pipe joins iron pipe.

Estimate on all solder joints (wiped), allowing 1 pound of solder for every inch inside diameter of the pipe.

**98. Water-Supply System.**—For water supplied from street mains, allow for permits, corporation tapping, and curb box.

Measure the service pipe from street main to cellar, and allow for a stop and waste cock inside the cellar wall.

Measure all horizontal distributing pipes from the plan views of the building and all vertical distributing pipes from the sectional drawings.

Measure all branches for the several fixtures on the different floors, to the lawn hydrants, etc.

Itemize the different kinds and classes of pipes.

Estimate lead, brass, and copper water pipes by the pound, and wrought water pipe by the linear foot.

Itemize all stop-cocks, pipe supports, straps, hangers, etc. separately.

Estimate all water-pipe fittings less than $1\frac{1}{2}$ inches by the pound.

Figure on brass solder-nipple connections in all places where lead pipes join iron pipes.

Estimate on kitchen boiler, sediment cock, and range connections; also on faucets for all fixtures other than those which are included in the costs of the fixtures.

Estimate on garden hydrants and lawn sprinklers, and allow a stop and waste cock in cellar for each.

**99. Well Supply.**—For water supplied from a well, figure on double-action force pump in kitchen or laundry if the well is not deeper than 26 feet below the pump; for a deep well, estimate on a pumping engine or a windmill.

Measure lead tank linings in square feet, and estimate by the pound, allowing 1 pound of solder for every 2 feet of seams.

Allow 2 feet of lead pipe to connect iron pipes to house tank, and for stop-cocks close to tank.

Provide for telltale and overflow pipes for tank.

Estimate copper tanks in square feet and by the pound.

If there are iron, slate, glass, or cedar tanks, figure them separately.

**100. Fixtures.**—Estimate each **fixture** separately, and include traps, faucets, waste, vent, and water connections to walls or floors. When the sewer is long and has but little fall, figure on using a grease trap for the kitchen sink.

### GAS-FITTING

**101. Cost.**—The cost of the **gas-fitting** may be approximately figured as about 3 per cent. of the cost of the building. The cost of labor alone varies from about one-fourth to one-seventh of the cost of materials. The better the grade of fixtures, the lower will be the ratio, provided there is no excessive ornamentation requiring much time to put in place, as the cost of the labor is about the same for cheap fixtures as for more costly ones.

**102.** Estimate piping the same as for plumbing.

Allow for meter, permits, tapping gas main, etc.

Figure each gas fixture separately set up in place. The owner usually makes a selection of fixtures from the manufacturer's catalog. Allow for shields, fire-guards, etc. in places where there is danger of fire.

Figure gas grates, gas stoves, gas heaters, etc. separately. Where the gas pressure is very high or unsteady, allow for a pressure regulator.

## PAINTING AND PAPERING

### PAINTING

**103. Painting** is measured by the superficial yard, girting every part of the work that is covered by paint, and allowing additions to the actual surface to compensate for the difficulty of covering deep quirks of moldings, for carved and enriched surfaces, etc. Ordinary door and window openings are usually measured solid, to compensate for the extra time taken in working around them, "cutting in" the window sash, etc. Porch and stair balustrades, iron

railings, and work having numerous thin strips, are also counted solid, for a similar reason. Allowance is frequently made for the distance from the ground that the work is to be done, as in cornices, balconies, dormers, etc., and also for the difficulty of access.

Charges are usually made for each coat of paint put on, at a certain price per superficial yard and per coat.

Graining and marbling (imitations of wood and stone) and varnishing are rated at different prices from plain work.

Capitals and columns and other ornamental work that is difficult to measure should be enumerated, and a clear description of the amount of work on them should be given.

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### DATA ON PAINTING

**104. Quantities.**—One pound of pure lead-and-oil paint will cover from $2\frac{3}{4}$ to $3\frac{1}{4}$ square yards of wood for the first coat, and from $4\frac{1}{2}$ to 6 square yards for each additional coat; on brickwork, it will cover about $1\frac{1}{2}$ and 2 square yards, respectively. Colored paint will cover about one-third more surface than white paint.

Using prepared or ready-mixed paint, 1 gallon will cover from 250 to 300 square feet of wooden surface, two coats; for covering metallic surfaces, 1 gallon will be sufficient for from 300 to 400 square feet, one coat. The weight per gallon of pure mixed paints varies considerably, but, on an average, may be taken at about 16 pounds.

Prepared shingle stains will cover about 200 square feet of surface per gallon if applied with a brush; or, this quantity will be sufficient for dipping about 500 shingles. Rough-sawed shingles will require about 50 per cent. more stain than smooth ones.

One pound of cold-water paint, for the first coat, will cover from 50 to 75 square feet of wood, according to the surface condition, and about 40 square feet of brick and stone.

One gallon of liquid pigment filler, hard-oil finish, or varnish will generally cover from 350 to 450 square feet of surface for the first coat, according to the nature of the wood

and the finish, and from 450 to 550 square feet for the second and subsequent coats. One pound of paste wooden filler will cover about 40 square feet.

One gallon of varnish weighs from 8 to 9 pounds; turpentine, about 7 pounds; and boiled or raw linseed oil, about $7\frac{3}{4}$ pounds.

For puttying, about 5 pounds of putty will be sufficient for 100 square yards of interior and exterior work.

For sizing, about $\frac{1}{2}$ pound of glue is used to 1 gallon of water.

For mixing paints, the figures given in Table XIV represent the average proportions of materials required for each 100 pounds of lead.

TABLE XIV

QUANTITIES OF MATERIALS

| Coat | Lead Pounds | Raw Oil Gallons | Japan Drier Gallon | Turpentine Gallons |
|---|---|---|---|---|
| Priming . . . . | 100 | 7 | $\frac{1}{2}$ | — |
| Second . . . . | 100 | 4 | — | 2 |
| Third . . . . . | 100 | $6\frac{1}{2}$–7 | — | $\frac{1}{2}$ |

The drier is omitted in the second and succeeding coats, unless the work is to be dried very rapidly, as it is considered to be injurious to the durability of the paint.

On outside work, boiled oil is generally used in about the proportion of 1 gallon to 2 gallons of raw oil.

**105. Care in Painting.**—In painting woodwork, putty should not be used until after the first coat of paint or varnish has been applied. There are two reasons for this. In the first place, if putty is used on dry wood, the wood is liable to absorb the oil from the putty and leave it in a dry and crumbly condition. Then, also, the oil from the putty soaking into the wood will stain the wood dark, and this stain may be seen through varnish. For this latter reason, putty should be put in cracks and holes with a putty knife

and not with the fingers, as otherwise the oil from the putty will get over the fingers and thus be transferred to the woodwork, where it will show as a dark stain if the wood is varnished.

Due care should also be taken in painting woodwork that has knots in it, as otherwise the turpentine in the knot will be sure to discolor the paint in course of time. To avoid this, the knots should be coated, or *killed*, with a coat of shellac before the first coat of paint is applied. The shellac prevents the turpentine in the knot from soaking through and discoloring the paint.

**106. Cost of Painting.**—The cost of applying paint on general interior and exterior work will average about twice the cost of the materials, while for very plain work, done in one color, the cost may be taken at about $1\frac{1}{2}$ times that of the materials. For stippling, the cost will be about the same as for two coats of paint. For varnishing, the cost of labor will be about $1\frac{1}{2}$ times the price of the varnish.

The following figures represent fair average prices, for various classes of work, and have been adopted by the Builders' Exchange of a large eastern city:

| Interior Work | Cost Per Square Yard Cents |
|---|---|
| 1 coat of paint, including shellacking knots | 10 |
| 2 coats of paint, including puttying | 20 |
| 3 coats of paint, including puttying | 25 to 30 |
| 1 coat of shellac | 15 |
| Walls, 1 coat of size, 2 coats of paint | 20 |
| Walls, 1 coat of size, 3 coats of paint, stippled | 30 |
| *Hardwood Finish* | |
| 1 coat of paste filler, 1 coat of varnish | 25 |
| 1 coat of paste filler, 2 coats of varnish | 40 |
| 1 coat of paste filler, 3 coats of varnish | 50 |
| 1 coat of paste filler, 3 coats of varnish, rubbed down to dull finish | 60 to 75 |

| *Finish on Soft Woods* | Cost Per Square Yard Cents |
|---|---|
| 1 coat of liquid filler, 1 coat of varnish | 20 |
| 1 coat of liquid filler, 2 coats of varnish | 30 |
| 1 coat of liquid filler, 3 coats of varnish, rubbed | 50 |
| Floors: filling, shellacking, varnishing, or waxing, 2 coats (or 4 coats in all) | 40 |
| *Tinting Walls (Cold-Water Paint)* | |
| Tinting, 50 yards or less, including sizing | 12 |
| Tinting, 50 yards or more, including sizing | 10 |

**107.** In **staining** hardwoods with open grain, such as oak, chestnut, ash, etc., it is customary, when a varnished surface is required, to stain the paste filler with oil colors so as to secure the desired tint and then finish with three or four coats of varnish. The staining adds about 5 cents per square yard to the cost of varnishing.

When it is desired to color the silver grain, or medullary rays, revealed in quarter-sawed material, the usual plan is first to stain the material with an oil or an aniline stain that permanently affects only the silver grain. Afterwards, the paste filler colored to the desired tint is applied, and this, on entering and closing the open grain, buries the first stain, but does not cover that over the medullary rays. This, as in the previous method of staining, adds about 5 cents a square yard to the cost of varnishing.

Another method of treating oak, chestnut, and ash is to stain the wood to the desired shade with an oil stain of the proper tint. This stain is applied with cheesecloth to an even surface, and, after puttying, one coat of flat varnish is applied. This process costs about 25 cents per square yard.

For silver-gray effects, the addition of aluminum bronze to the oil stain will give a pleasing effect. This costs about 28 cents per square yard.

When it is desired to have the open grain show a white effect, the usual method is to use a paste filler with zinc white added and then a coat of flat varnish. This costs about 30 cents per square yard.

Oak, chestnut, and ash may be colored by fuming (to give the effect of age) with the vapors of ammonia released in a closed box. This effect is also produced by several patented processes. It costs about 30 cents per square yard.

| Exterior Painting | Cost per Square Yard |
|---|---|
| *Woodwork* | Cents |
| 1 coat of paint | 10 |
| 2 coats of paint, including puttying | 18 |
| 3 coats of paint, including puttying | 25 to 30 |
| *Common and Pressed Brickwork* | |
| 1 coat of paint | 15 |
| 2 coats of paint | 25 |
| 3 coats of paint | 35 |
| Penciling and lining joints on painted brickwork | 05 |
| Penciling joints on pressed, unpainted brickwork | 10 |
| *Sanding* | |
| 2 coats of paint, 1 coat of sand | 28 |
| 3 coats of paint, 1 coat of sand | 35 |
| *Miscellaneous* | Cost |
| Dipping shingles, per 1,000 | $3.00 |
| Additional coat, per 1,000 shingles | .50 |
| Brush-coating shingles, per square yard | .15 |
| Blinds, per square foot, 1 coat, painted on both sides | .04 |
| Additional coat for blinds, per square foot | .04 |
| Iron fence, per square foot, 1 coat, painted on both sides | .04 |
| Tin roof, per square yard, 1 coat | .05 |
| Additional coat for tin roof, per square yard | .04 |

Note.—For painting sand-lime bricks, double the prices given for common and pressed brickwork.

### PAPERING

**108. Papering** is usually figured per roll, put on the wall. The paper is generally 18 inches wide, and is in 8-yard rolls; double rolls are 16 yards. On account of waste in

matching, etc., it is difficult to estimate very closely the number of rolls required, but an approximate result may be obtained as follows: Divide the perimeter of the room by $1\frac{1}{2}$ (the width of paper in feet); the result will be the number of strips. Find the number of strips that can be cut from a roll, and divide the first result by the second; the quotient will be the number of rolls required. No openings less than 20 square feet in area should be deducted, in order to compensate for cutting and fitting at such places. About 15 per cent. should be added to the area to allow for waste. The border, whether wide or narrow, is generally figured as one roll of paper.

The cost of paper is extremely variable, ranging from 15 cents to $6 per roll; the average cost is probably 25 to 50 cents per roll, for ordinary houses. Paper hanging costs from 10 cents to $1 per roll, according to quality, with strips butted.

## GLAZING

**109. Glazing** was formerly included in the painter's contract, but as it is now customary and more convenient to oil or paint and glaze the sash at the mill when they are made, the glazing is included in the joinery specifications, and is not considered as a separate subdivision of estimating work.

In measuring glass, take the dimensions between rabbets each way when the panes are rectangular; if irregular or circular in form, take the extreme dimensions, and consider the panes rectangular. It costs about $1\frac{1}{2}$ cents per square foot of light to glaze a window. This price includes the cost of putty.

Polished plate glass is used extensively for store-front windows and also for glazing window sash in fine work. There are three qualities: French plate, and two grades of American plate, which may be obtained in various sizes up to 8 feet wide and 14 feet long. The cost of plate glass is estimated by the aid of a price list that gives the cost of the various sizes. This list is furnished by dealers and remains

the same from year to year; it is known as the *standard list.* The fluctuations are provided for by means of a discount, which is the same for all sizes of glass.

## TABLE XV

### PANES OF WINDOW GLASS PER BOX

| Size Inches | Panes in Box | Size Inches | Panes in Box | Size Inches | Panes in Box | Size Inches | Panes in Box |
|---|---|---|---|---|---|---|---|
| 6 × 8 | 150 | 16 × 22 | 21 | 22 × 28 | 12 | 26 × 58 | 5 |
| 7 × 9 | 115 | 16 × 24 | 15 | 22 × 30 | 11 | 28 × 28 | 9 |
| 8 × 10 | 90 | 16 × 34 | 13 | 22 × 32 | 10 | 28 × 30 | 9 |
| 8 × 12 | 75 | 16 × 38 | 12 | 22 × 34 | 10 | 28 × 42 | 6 |
| 9 × 11 | 73 | 16 × 44 | 10 | 22 × 36 | 9 | 28 × 52 | 5 |
| 9 × 12 | 67 | 18 × 20 | 20 | 22 × 38 | 9 | 30 × 30 | 8 |
| 9 × 13 | 62 | 18 × 22 | 18 | 22 × 48 | 7 | 30 × 40 | 6 |
| 10 × 12 | 60 | 18 × 24 | 17 | 22 × 52 | 6 | 30 × 50 | 5 |
| 10 × 14 | 52 | 18 × 26 | 16 | 24 × 24 | 12 | 30 × 54 | 4 |
| 10 × 16 | 45 | 18 × 32 | 13 | 24 × 26 | 12 | 32 × 32 | 7 |
| 10 × 18 | 40 | 18 × 36 | 11 | 24 × 28 | 11 | 32 × 36 | 6 |
| 12 × 14 | 43 | 18 × 42 | 10 | 24 × 30 | 10 | 32 × 48 | 5 |
| 12 × 16 | 38 | 18 × 52 | 8 | 24 × 32 | 10 | 32 × 52 | 4 |
| 12 × 18 | 34 | 20 × 20 | 18 | 24 × 34 | 9 | 32 × 58 | 4 |
| 12 × 20 | 30 | 20 × 22 | 16 | 24 × 36 | 9 | 32 × 62 | 4 |
| 12 × 22 | 27 | 20 × 24 | 15 | 24 × 38 | 8 | 34 × 34 | 6 |
| 12 × 24 | 25 | 20 × 26 | 14 | 24 × 40 | 8 | 34 × 36 | 6 |
| 14 × 16 | 32 | 20 × 28 | 13 | 24 × 42 | 7 | 34 × 46 | 5 |
| 14 × 18 | 29 | 20 × 30 | 12 | 24 × 44 | 7 | 34 × 50 | 4 |
| 14 × 20 | 26 | 20 × 34 | 11 | 24 × 46 | 7 | 34 × 56 | 4 |
| 14 × 22 | 24 | 20 × 36 | 10 | 24 × 52 | 6 | 36 × 36 | 6 |
| 14 × 24 | 22 | 20 × 38 | 10 | 24 × 60 | 5 | 36 × 44 | 5 |
| 14 × 26 | 20 | 20 × 40 | 9 | 26 × 26 | 11 | 36 × 48 | 4 |
| 14 × 36 | 14 | 20 × 52 | 7 | 26 × 28 | 10 | 36 × 54 | 4 |
| 14 × 40 | 13 | 22 × 22 | 15 | 26 × 32 | 9 | 36 × 58 | 3 |
| 16 × 18 | 25 | 22 × 24 | 14 | 26 × 44 | 6 | 36 × 64 | 3 |
| 16 × 20 | 23 | 22 × 26 | 13 | 26 × 52 | 5 | 40 × 60 | 3 |

When stained or art glass is used, the specifications generally limit the cost, as the glass is made according to the architect's designs or to approved designs submitted by manufacturers. The price depends more on the amount of lead or copper used than on the cost of the glass itself, and therefore no very close estimate can be made. The following figures are only approximate:

| | Cost Per Square Foot |
|---|---|
| Clear glass | $1 to $3 |
| Opalescent glass | $1 to $3 |
| Plate glass | $2 to $4 |
| Cathedral glass | $3 to $5 |
| Favrille glass | About $8 |

Ordinary window, or sheet, glass is sold by the box, which contains, as nearly as possible, 50 square feet, whatever the size of the glass may be. There are two qualities of ordinary glass, known as *single* and *double thick*, the former being about $\frac{1}{16}$ inch thick, and the latter nearly $\frac{1}{8}$ inch. Single-thick glass should never be used in panes over 24 in. × 24 in. in size. Table XV gives the number of panes of window glass in one box of 50 square feet.

# ESTIMATING AND CALCULATING QUANTITIES
(PART 2)

## EXAMPLE IN ESTIMATING

**1.** Following the rules and suggestions already given in *Estimating and Calculating Quantities*, Part 1, the estimate for a house will be made as a practical example, the drawings on which it is based being shown in the accompanying plates. In making the estimate, the various portions of the work are taken in the order in which they naturally occur in the erection of the building, following, as closely as possible, the estimating schedule heretofore given.

As far as possible, the figures given in the example should be checked up by taking off quantities and performing all the indicated work. It is only by actually making the calculations that any practical benefit from the work will be derived. *No two estimators, working separately, will arrive at exactly the same results; therefore, in following the calculations in this example, some discrepancies between the figures of the person performing the estimating and the ones given will no doubt be found.* These discrepancies should not be important ones, however, and by carefully studying the methods followed, results substantially the same as those computed here should be obtained.

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## EXCAVATION

**2.** In calculating the cubic yards of earth excavated for the cellar, all measurements are taken from the foundation plan and the sections. The plan is blocked out as shown in the accompanying Cellar Plan, and the area of each block found; then, by multiplying the sum of these partial areas by the depth of the cellar, the cubic contents is determined. The trenches for the foundation walls of porches and for the footings of cellar walls are calculated separately, as also are the excavations for piers, drains, cesspools, area, etc.

CELLAR EXCAVATION

| *Quantities* | | SQUARE FEET | CUBIC FEET |
|---|---|---|---|
| Block *A*, 23′ 4″ × 16′ 4″ . . . . | | 381.0 | |
| Block *B*, 14′ 6″ × 20′ 10″ . . . . . | 302.0 | | |
| Deduct 4″ × 3′ 0″ . . . . . | 1.0 | | |
| Add for projection of wall, $\frac{13' 6'' + 7'}{2} \times 3' =$ . . . . . | 30.8 | | |
| | | 331.8 | |
| Block *C*, 27′ 6″ × 17′ 5″ . . . . . | 479.0 | | |
| Deduct for breaks in wall, 1′ 7″ × 6′ 8″ and 2′ 6″ × 3′ . . . . | 18.0 | | |
| | | 461.0 | |
| Block *D*, 26′ 6″ × 10′ 5½″ . . . . . | | 277.2 | |
| Block *E*, 16′ 8″ × 11′ 6½″ . . . . . | 192.4 | | |
| Deduct for breaks in wall, 6′ 6″ × 1′ 11″ and 3′ × 5″ . . . . . | 13.7 | | |
| | | 178.7 | |
| * Block *F*, 9′ 10″ × 9′ 7½″ ÷ 2 . . . | | 47.3 | |
| * Block *G*, 14′ × 14′ × .7854 ÷ 2 . . | 77.0 | | |
| Deduct for portion of semicircular part, included in *F*, 12″ × 14′ approximately . . . . . | 14.0 | | |
| | | 63.0 | |
| Total area of excavation . . . . | | 1,740.0 | |
| Contents, 1,740 sq. ft. × 6.5 ft. (depth) . . . . . | | | 11,311.0 |

* The block *F* is taken as a triangle. The block *G* is a semicircle, and its area is found, as will be noticed, by finding the area of a circle and dividing it by 2.

EXCAVATION FOR WALL FOOTINGS*

| *Quantities* | SQUARE FEET | CUBIC FEET |
|---|---|---|
| *a b*, 26′ × 2′ 6″ | 65.0 | |
| *b c*, 5′ 6″ × 3′ | 16.5 | |
| *c d*, 9′ 9″ × 2′ 6″ | 24.4 | |
| *d e*, 17′ 6″ × 2′ 6″ | 43.7 | |
| *e f*, 27′ 4″ × 2′ 6″ | 68.3 | |
| *f g*, 9′ 2″ × 3′ 8″ | 33.6 | |
| *g h*, 21′ × 2′ 6″ | 52.5 | |
| *i j*, 27′ 7″ × 2′ 6″ | 69.0 | |
| *j a*, 31′ × 2′ 6″ | 77.5 | |
| *k l*, 20′ 2″ × 2′ 6″ | 50.4 | |
| Chimney, 12′ 6″ × 4′ (approximately) 50 | | |
| Deductions . . . . . 10.4 | 39.6 | |
| *q r*, 16′ 4″ × 1′ 10″ | 29.9 | |
| *r s*, 9′ 2″ × 1′ 10″ | 16.8 | |
| *m n* (less openings), 7′ 9″ × 2′ 6″ | 19.4 | |
| *o p*, 20′ × 1′ 10″ | 36.7 | |
| Total area of excavation for footings | 643.3 | |
| Contents, 643.3 sq. ft. × 10 in. (.833 ft.) depth | | 535.9 |

MISCELLANEOUS EXCAVATIONS*

| *Quantities* | CUBIC FEET |
|---|---|
| Front porch, 69′ 9″ × 2′ 3″ × 3′ | 470.8 |
| Back porch, 24′ × 2′ 4″ × 3′ | 168.0 |
| Piers for steps, 1′ 8″ × 2′ × 3′ × 2 | 20.0 |
| Piers for side steps and back porch, 2′ × 2′ × 3′ × 4 | 48.0 |
| Cellar area, 5′ 9″ × 6′ 4″ × 6′ 6″ . . . . . 236.7 | |
| Deduct 2′ × 3′ × 6′ 6″ . . . . . 39.0 | |
| | 197.7 |
| Dry cesspool, 6 ft. diameter × 6 ft. depth | 169.6 |
| Cesspool, 6 ft. diameter × 8 ft. depth | 226.2 |
| Trench for pipe to cesspool, 25′ × 7′ 6″ × 2′ | 375.0 |
| Trench for drain pipes (roof drainage), 228′ × 3′ × 1′ | 684.0 |
| Trench for drain pipes from junction to dry cesspool, 20′ × 3′ × 18″ | 90.0 |
| Total | 2,449.3 |
| Grand total of excavation | 14,296.2 |

*Lengths scaled along center line of walls.

FILLING

| *Quantities* | CUBIC FEET |
|---|---|
| Around foundation walls, 181′ 2″ × 6″ × 6′ 6″ . . . | 588.8 |
| Around foundation of porches, etc., 142′ 3″ × 6″ × 3′ | 213.4 |
| Total filling . . . . . | 802.2 |

*Cost*

The cost of excavation in sandy soil, taken from *Estimating and Calculating Quantities*, Part 1, is 53 cents per cubic yard. The cost of filling, including tamping, may be taken as about one-third that of excavation, or, say, 18 cents per cubic yard.

*Summary*

| | |
|---|---|
| Excavation, 14,296.2 cu. ft. = 529.5 cu. yd., at 53 cents per cubic yard . . . . . | $280.64 |
| Filling, 802.2 cu. ft. = 29.7 cu. yd., at 18 cents per cubic yard . . . . . | 5.35 |
| Total cost of excavation and filling . . . . . | $285.99 |

## STONEWORK

**3.** The foundation walls are built of rubble masonry to the sill at the grade line, and from this sill to the water-table they are built of ashlar with rubble backing, except those portions behind porches and steps, which are wholly rubble. The estimate for stonework also includes the concrete for footings and cellar floor; the number of cubic feet of concrete required for the footings will be found by referring to the item Excavation for Wall Footings.

RUBBLE MASONRY

| *Quantities* * | | CUBIC FEET |
|---|---|---|
| Cellar walls, 181′ 2″ × 1′ 6″ × 6′ 6″ . . . . . | | 1,766.4 |
| Add for extra thickness over 1′ 6″: | | |
| 5″ × 6′ 3″ × 6′ 6″ . . . . . | 16.9 | |
| 1′ 2″ × 10′ 8″ × 6′ 6″ . . . . . | 80.9 | |
| | | 97.8 |

* External measurements with no deduction for openings.

| | | Cubic Feet |
|---|---|---|
| *Foundation walls for front porch: | | |
| 74′ 6″ × 1′ 8″ × 1′ 9″ | 217.3 | |
| 74′ 6″ × 1′ 2″ × 9″ | 65.2 | |
| | | 282.5 |
| Foundation for steps: | | |
| 2 piers, 1′ 6″ × 1′ 8″ × 2′ 6″ | 12.5 | |
| 2 piers, 2′ × 1′ 6″ × 2′ 6″ | 15.0 | |
| | | 27.5 |
| Stone footings under porch foundations, 74′ 6″ × 2′ 3″ × 6″ | | 83.8 |
| Backing for ashlar and water-table, 79′ 10″ × 1′ (average) × 3′ | | 239.5 |
| Rubble wall behind porches, 101′ 4″ × 1′ 6″ × 3′ (approximately) | | 456.0 |
| *Foundation walls, rear porch, 26′ 10″ × 1′ 6″ × 2′ 6″ | | 100.6 |
| Footings, walls rear porch, 26′ 10″ × 2′ 4″ × 6″ | | 31.3 |
| Area walls, 13′ 9″ × 1′ × 6′ 6″ | | 89.4 |
| Stone footing for area walls, 13′ 9″ × 1′ 9″ × 6″ | | 12.0 |
| Piers, 1′ 6″ × 1′ 6″ × 2′ 6″ × 2 | | 11.3 |
| Pier footings, 2′ × 2′ × 6″ × 4 | | 8.0 |
| Pier footings, 2′ × 1′ 9″ × 6″ × 2 | | 3.5 |
| Total rubble masonry | | 3,209.2 |

*Cost*

The cost of the rubble masonry based on the analysis given in *Estimating and Calculating Quantities*, Part 1, using 1–3 Portland cement mortar, is $5.23 per perch.

*Summary*

From the foregoing calculation, the quantity of rubble masonry is 3,209.2 cu. ft. Taking 25 cu. ft. to 1 perch, 3,209.2 ÷ 25 = 128.4 perches, which at $5.23 per perch makes the total cost of rubble masonry $671.53.

*Although these are made continuous, to carry the base, or ground sill, independent piers, under the porch columns might be substituted, at a somewhat less cost.

ASHLAR *

*Quantities*

| | SQUARE FEET |
|---|---|
| Facing for cellar walls, 79′ 10″ × 2′ 2″ | 173.0 |
| Porch piers, 29′ 6″ × 1′ 6″ | 43.9 |
| Total ashlar | 216.9 |

*Cost*

The estimated cost of ashlar is based on the following analysis of the cost of 1 square foot of ashlar:

| | |
|---|---|
| Cost of stone, bluestone facing | $.40 |
| Hauling stone | .03 |
| Mortar | .01 |
| Labor, estimating 64 square feet per day of 8 hours, for two masons and one laborer: | |
| Two masons, at $3.20 per day | .10 |
| One laborer at $2 per day | .03 |
| Cost per square foot | $.57 |

*Summary*

From the foregoing quantities, the ashlar amounts to 216.9 square feet, which, at 57 cents per square foot, will make the total cost of ashlar $123.63.

CUT STONE

| *Quantities and Cost* | COST PER FOOT | TOTAL COST |
|---|---|---|
| Base, or ground sill, extending around porches (except under stone steps) and along exposed main walls, 172 ft., 5″ × 11″ and 5″ × 13″ dressed and chamfered sandstone | $1.00 | $172.00 |
| Water-table, extending around main walls, 181 ft. 2 in., 6″ × 10″ dressed and chamfered sandstone | .85 | 153.99 |
| Lintel course, extending over brick walls, 125 ft., 6″ × 10″ dressed sandstone | .85 | 106.25 |
| Twelve dressed sandstone window sills, cut with lug and drip, 55¾ ft., 5″ × 8″ | .65 | 36.24 |

* The walls between the base sill and the water-table are faced with ashlar, which extends around the main walls to the porches, and all porch piers are built of ashlar.

| | Cost Per Foot | Total Cost |
|---|---|---|
| Cut-stone jambs and lintel for main door, $21\frac{1}{2}$ ft., $10'' \times 12''$, sandstone | $1.75 | $37.63 |
| One front door sill, $5\frac{3}{4}$ ft., $6'' \times 10''$, sandstone | 1.10 | 6.33 |
| Coping on area walls, 9 ft., $3'' \times 16''$, sandstone | .60 | 5.40 |
| Front and side porch steps, 59 ft., $8'' \times 12''$, dressed sandstone | 1.25 | 73.75 |
| Eight bluestone steps for cellar, outside entrance, $4' \times 12'' \times 2''$ | .35 | 11.20 |
| Bluestone lintel for kitchen fireplace, $6' \times 12'' \times 6''$ | 1.20 | 7.20 |
| Cut stone for main chimney | | 25.00 |
| Cost to set cut stone, 20 per cent. | | 127.00 |
| Total cost of cut stone | | $761.99 |

### Concrete Footings and Floor

*Quantities*

| | Cubic Yard |
|---|---|
| Footings, as per Excavation for Wall Footings, 535.9 cu. ft. ÷ 27 | 19.8 |

| Concrete floor: | Square Feet | Square Yard |
|---|---|---|
| Area of cellar excavation | 1,740.0 | |
| Deduct area of footings | 643.3 | |
| | 1,096.7 | |
| Add for 6-inch strip over inner projection of wall footings, $165' \times 6''$ | 82.5 | |
| Add for projection on both sides of interior walls, $126' \times 6''$ | 63.0 | |
| Add for projection over chimney footing, $33' \times 6''$ | 16.5 | |
| Total area of concrete floor | 1,258.7 | = 139.9 |

*Cost*

The estimate for concrete footings is based on the analyses of costs given in *Estimating and Calculating Quantities*, Part 1, and is $5.10 per cubic yard for a 1–3–5 mixture.

The estimate for the concrete floor is arrived at as follows:

The concrete will be a 1–3–6 mixture. According to *Estimating and Calculating Quantities*, Part 1, this mixture costs $4.92 per cubic yard. According to the same section, 25 cents must be added to this cost for extra labor, bringing the total up to $5.17 per cubic yard. If the concrete floor is 4 inches thick, the cost per square yard will be $\frac{4}{36} \times 5.17 = 57$ cents, approximately. The top coat, according to *Estimating and Calculating Quantities*, Part 1, is 40 cents. Therefore, the total cost of the concrete floor per square yard is $57 + 40 = 97$ cents.

*Summary*

| | |
|---|---|
| Footing concrete, as per foregoing figures, 19.8 cu. yd. at $5.10 per cubic yard | $100.98 |
| Concrete floor, 139.9 sq. yd. at 97 cents per square yard | 135.70 |
| Total cost of concrete | $236.68 |

*Recapitulation of Cost of Stonework*

| | |
|---|---|
| Rubble masonry | $ 671.53 |
| Ashlar masonry | 123.63 |
| Cut stone | 761.99 |
| Concrete footings and floor | 236.68 |
| Total cost of stonework | $1,793.83 |

## BRICKWORK

**4.** In estimating the brickwork, openings have been deducted, thus practically giving "kiln count," so that the analyses of prices given heretofore will apply. If openings had not been deducted, the prices would be 15 per cent. lower.

PRESSED BRICK

| *Quantities* | No. Brick |
|---|---|
| Facing exterior walls, same length as stone lintel course, 125′ × 8′ = 1,000 sq. ft. at 7½ bricks per square foot | 7,500 |

| Deduct for openings: | Square Feet | No. Brick |
|---|---|---|
| Nine windows, total width 32′ × 6′ 6″ high | 208.0 | |
| Two casement windows, total width 7′ 4″ × 8′ high | 58.7 | |
| One lavatory window, total width 2′ × 6″ × 5′ 6″ | 13.8 | |
| Main door, 5′ 5″ × 8′ 9″ | 47.4 | |
| Total deductions | 327.9 | |
| 327.9 × 7½ = | | 2,459 |
| Number of brick | | 5,041 |
| Add 5 per cent. for waste | | 252 |
| Total pressed brick | | 5,293 |

*Cost*

The cost of pressed brickwork is based on the analysis given in *Estimating and Calculating Quantities*, Part 1, and is $53.71 per thousand.

*Summary*

| | |
|---|---|
| From the preceding estimate of quantities, the number of pressed brick laid is 5,041, which, at $53.71 per M, will cost | $270.75 |
| Pressed brick, not laid, 252, at $30 per M | 7.56 |
| Total cost of pressed brickwork | $278.31 |

Common Brick

*Quantities*

| | No. Brick |
|---|---|
| Backing exterior pressed-brick walls, 8½ in. thick, 5,041 × 2 = | 10,082 |
| Backing behind lintel course, 9″ × 125′ × 8″ at 15 brick per sq. ft. | 1,406 |
| Interior cellar walls, 28′ 4″ × 8′ = 226.7 sq. ft. (17-inch wall) at 30 brick per square foot | 6,801 |
| Deduct for three openings, 12′ 3″ total width × 6′ 6″ height = 79.6 sq. ft. at 30 brick per square foot | 2,388 |
| | 4,413 |

| | No. Brick |
|---|---|
| Interior wall, $8\frac{1}{2}''$ thick, $43' 9'' \times 8'$, 350 sq. ft. at 15 brick per square foot | 5,250 |
| Chimney, principal (flues figured solid), approximately 920 cu. ft., at $22\frac{1}{2}$ brick per cubic foot | 20,700 |
| Chimney, rear, approximately 245 cu. ft., at $22\frac{1}{2}$ brick per cubic foot | 5,513 |
| Trap pits, 46 sq. ft., at $7\frac{1}{2}$ brick per square foot | 345 |
| | 46,303 |
| Add 5 per cent. for waste | 2,315 |
| Total common brick | 48,618 |

*Cost*

The cost of the common brickwork is based on the analysis given in *Estimating and Calculating Quantities*, Part 1, and is $16.68 per thousand for lime-cement mortar.

*Summary*

| | |
|---|---|
| According to the estimate of quantities, the number of common brick laid is 46,303, which, at $16.68, will cost | $ 772.33 |
| Common bricks, not laid, 2,315, at $8 | 18.52 |
| Molded brick and terra-cotta cap for rear chimney | 10.00 |
| Total cost of common brickwork | $ 800.85 |

*Recapitulation of Cost of Brickwork*

| | |
|---|---|
| Pressed brickwork | $ 278.31 |
| Common brickwork | 800.85 |
| Total cost of brickwork | $1,079.16 |

## CARPENTRY

**5.** In estimating carpentry work, it is advisable to make a tabulated list of the various sizes of joists, rafters, etc., giving the number and dimensions of each size. In this way, any error in calculation or change in price can be corrected with little difficulty.

As house-framing timbers and boards are sold at the yards in even lengths, as 10 feet, 12 feet, 14 feet, etc., uneven,

or odd, measurements must be figured in even lengths from which they can be cut. Thus, if a stick 14 feet 7 inches in length is required, a 16-foot stick must be ordered.

Usually, the price per thousand feet, board measure, increases as longer sticks are used, although the practice varies in different localities. For example, in most localities hemlock timber in 10-, 12-, or 14-foot lengths is all one price per thousand, but a thousand feet, board measure, of 16-foot lengths costs more, and 18-foot lengths is still more expensive. The price of yellow pine, spruce, fir, etc. is usually constant up to 20-foot lengths, but from that length on the prices increase. The price of white-pine boards in most localities increases with their width. The hardwoods can be usually obtained in any reasonable length, the price increasing with the quality of the lumber more than with the length of the stick.

It can thus be seen that in house framing it is usually cheaper to use short sticks than long ones. However, for long members, a long stick is cheaper, because the extra cost that would be incurred in splicing two short sticks would more than offset the cheapness of the material. Of course, when very long sticks are required, say sticks 30 feet or more in length, a splice is cheaper, owing to the difficulty of obtaining them and their very excessive price.

No set rules can be laid down as to what size timber should be ordered, and every architect and builder should be governed by the prices in the locality where the house is to be put up.

FLOOR FRAMING, FIRST STORY

| *Quantities* | LINEAR FEET | FEET B. M. |
|---|---|---|
| Joists, 3″ × 10″; 2½ ft. B. M., per lin. ft.: | | |
| 6 pieces, each 14′ 6″, order 16′ . . . . . | 96 | |
| 2 pieces, each 15′ 3″, order 16′ . . . . . | 32 | |
| 1 piece, 16′ 3″, order 18′ . . . . . | 18 | |
| 5 pieces, each 17′ 6″, order 18′ . . . . . | 90 | |
| 1 piece, 12′ 6″, order 14′ . . . . . | 14 | |
| 6 pieces, each 11′ 0″, order 12′ . . . . . | 72 | |
| 1 piece, 9′ 6″, order 10′ . . . . . | 10 | |

| | Linear Feet | Feet B. M. |
|---|---|---|
| 18 pieces, each 14′, order 14′ | 252 | |
| 1 piece, 11′ 6″, order 12′ | 12 | |
| 3 pieces, each 10′ 6″, order 12′ | 36 | |
| 1 piece, 9′ 4″, order 10′ | 10 | |
| 6 pieces, each 24′, order 24′ | 144 | |
| 1 piece, 11′ 4″, order 12′ | 12 | |
| 2 pieces, each 20′ 6″, order 22′ | 44 | |
| 6 pieces, each 20′, order 20′ | 120 | |
| 4 pieces, each 21′, order 22′ | 88 | |
| 2 pieces, each 7′, cut out of 14′ | 14 | |
| 2 pieces, each 13′, order 14′ | 28 | |
| 1 piece, 10′, order 10′ | 10 | |
| Total | 1,102 | 2,755 |

Floor Framing, Second Story

*Quantities*

| | Linear Feet | Feet B. M. |
|---|---|---|
| Girder, 6″ × 12″; 6 ft. B. M., per lin. ft.: | | |
| 1 piece, 8′ 9″, order 10′ | 10 | 60 |
| Joists, 2″ × 10″; 1⅔ ft. B. M., per lin. ft.: | | |
| 15 pieces, each 14′, order 14′ | 210 | |
| 2 pieces, each 15′ 6″, order 16′ | 32 | |
| 5 pieces, each 17′, order 18′ | 90 | |
| 3 pieces, each 15′, order 16′ | 48 | |
| 14 pieces, each 16′, order 16′ | 224 | |
| 2 pieces, each 7′, cut out of 14′ | 14 | |
| 2 pieces, each 10′, order 10′ | 20 | |
| 4 pieces, each 11′, order 12′ | 48 | |
| 7 pieces, each 24′, order 24′ | 168 | |
| 3 pieces, each 20′ 6″, order 22′ | 66 | |
| 4 pieces, each 12′ 6″, order 14′ | 56 | |
| 2 pieces, each 13′ 6″, order 14′ | 28 | |
| Total | 1,004 | 1,673 |
| Joists, 3″ × 10″; 2½ ft. B. M., per lin. ft.: | | |
| (Headers) 2 pieces, each 8′ 9″, order 10′ | 20 | |
| 2 pieces, each 6′, cut out of 12′ | 12 | |
| 5 pieces, each 9′ 9″, order 10′ | 50 | |
| 11 pieces, each 19′ 6″, order 20′ | 220 | |
| | 302 | 755 |

FLOOR FRAMING, ATTIC

*Quantities*

| | Linear Feet | Feet B. M |
|---|---|---|
| Joists, 2″ × 10″; 1⅔ ft. B. M., per lin. ft.: | | |
| 15 pieces, each 14′, order 14′ | 210 | |
| 2 pieces, each 15′ 6″, order 16′ | 32 | |
| 5 pieces, each 17′, order 18′ | 90 | |
| 3 pieces, each 15′, order 16′ | 48 | |
| 14 pieces, each 16′, order 16′ | 224 | |
| 2 pieces, each 7′, cut out of 14′ | 14 | |
| 2 pieces, each 10′, order 10′ | 20 | |
| 4 pieces, each 11′, order 12′ | 48 | |
| 7 pieces, each 24′, order 24′ | 168 | |
| 3 pieces, each 20′ 6″, order 22′ | 66 | |
| 4 pieces, each 12′ 6″, order 14′ | 56 | |
| 2 pieces, each 13′ 6″, order 14′ | 28 | |
| Total | 1,004 | 1,673 |
| Joists, 3″ × 10″; 2½ ft. B. M., per lin. ft.: | | |
| 2 pieces, each 8′ 9″, order 10′ | 20 | |
| 2 pieces, each 6′, cut out of 12′ | 12 | |
| 5 pieces, each 9′ 9″, order 10′ | 50 | |
| 11 pieces, each 19′ 6″, order 20′ | 220 | |
| Total | 302 | 755 |

FLOOR FRAMING, FRONT PORCH

*Quantities*

| | Linear Feet | Feet B. M. |
|---|---|---|
| Joists, 3″ × 9″; 2¼ ft. B. M., per lin. ft.: | | |
| 3 pieces, each 7′, cut out of 14′ | 21 | |
| 1 piece, 6′ 9″, cut out of 14′ | 7 | |
| 2 pieces, each 10′, order 10′ | 20 | |
| 1 piece, 8′ 6″, order 10′ | 10 | |
| Total | 58 | 131 |
| Joists, 2″ × 6″; 1 ft. B. M., per lin. ft.: | | |
| 2 pieces, each 21′ 6″, order 22′ | 44 | |
| 2 pieces, each 19′ 3″, order 20′ | 40 | |
| 4 pieces, each 8′, cut out of 16′ | 32 | |
| 1 piece, 10′ 3″, order 12′ | 12 | |
| 6 pieces, each 9′, order 10′ | 60 | |

| | Linear Feet | Feet B. M. |
|---|---|---|
| 2 pieces, each 4′ 6″, cut out of 10′ | 10 | |
| 5 pieces, each 6′, cut out of 12′ | 30 | |
| 3 pieces, each 2′, cut out of 12′ | 6 | |
| 4 pieces, each 5′, cut out of 10′ | 20 | |
| 3 pieces, each 9′, order 10′ | 30 | |
| Total | 284 | 284 |

Floor Framing, Back Porches

*Quantities*

| | Linear Feet | Feet B. M. |
|---|---|---|
| Joists, 2″ × 6″; 1 ft. B. M., per lin. ft.: | | |
| 2 pieces, each 21′, order 22′ | 44 | |
| 3 pieces, each 8′, order 8′ | 24 | |
| Total | 68 | 68 |
| Joists, 3″ × 6″; 1½ ft. B. M., per lin. ft.: | | |
| *5 pieces, each 5′ 9″, cut out of 12′ | 36 | |
| 12 pieces, each 6′ 9″, cut out of 14′ | 84 | |
| 1 piece, 8′ 6″, order 10′ | 10 | |
| 2 pieces, each 3′ 6″, cut out of 8′ | 8 | |
| Total | 138 | 207 |

Bridging

*Quantities*

| | Linear Feet | Feet B. M. |
|---|---|---|
| 2″ × 4″; ⅔ ft. B. M., per lin. ft.: | | |
| First floor, 170 pieces, each 1′ 6″ | 255 | |
| Second floor, 138 pieces, each 1′ 6″ | 207 | |
| Third floor, 138 pieces, each 1′ 6″ | 207 | |
| Total | 669 | 446 |

Main-Roof Framing†

*Quantities*

| | Linear Feet | Feet B. M. |
|---|---|---|
| Rafters, 2″ × 6″; 1 ft. B. M., per lin. ft.: | | |
| 15 pieces, each 20′, order 20′ | 300 | |
| 14 pieces, each 19′ 3″, order 20′ | 280 | |
| 1 piece, 18′, order 18′ | 18 | |
| 2 pieces, each 16′, order 16′ | 32 | |

*One joist will be left over here, but this cannot easily be helped.

† In the attic plan, which shows the lines of the roof, the lines of the dormers are omitted so as to make the important hips and valleys more prominent.

| | Linear Feet | Feet B. M. |
|---|---|---|
| 2 pieces, each 14′, order 14′ | 28 | |
| 1 piece, 13′ 4″, order 14′ | 14 | |
| 3 pieces, each 10′ 6″, order 12′ | 36 | |
| 3 pieces, each 8′ 6″, order 10′ | 30 | |
| 1 piece, 6′ 9″, order 8′ | 8 | |
| 3 pieces, each 5′, cut out of 16′ | 16 | |
| 3 pieces, each 3′, cut out of 10′ | 10 | |
| 4 pieces, each 17′, order 18′ | 72 | |
| 1 piece, 12′ 6″, order 14′ | 14 | |
| 1 piece, 10′ 9″, order 12′ | 12 | |
| 2 pieces, each 9′, order 10′ | 20 | |
| 1 piece, 7′, order 8′ | 8 | |
| 18 pieces, each 9′ 6″, order 10′ | 180 | |
| 2 pieces, each 13′, order 14′ | 28 | |
| 2 pieces, each 7′ 9″, cut out of 16′ | 16 | |
| 2 pieces, each 6′ 6″, cut out of 14′ | 14 | |
| 4 pieces, each 3′ 6″, cut out of 14′ | 14 | |
| 4 pieces, each 8′, cut out of 16′ | 32 | |
| 2 pieces, each 11′, order 12′ | 24 | |
| 8 pieces, each 5′ 3″, cut out of 12′ | 48 | |
| 1 piece, 6′, cut out of 10′ | 6 | |
| 2 pieces, each 2′, cut out of 10′ | 4 | |
| 8 pieces, each 11′, order 12′ | 96 | |
| Total | 1,360 | 1,360 |
| Valley rafter, 3″ × 10″; $2\frac{1}{2}$ ft. B. M., per lin. ft.: | | |
| 1 piece, 24′ 6″, order 26′ | | 65 |
| Ridge plates, 2″ × 10″; $1\frac{2}{3}$ ft. B. M., per lin. ft.: | | |
| 1 piece, 23′ 6″, order 24′ | 24 | |
| 1 piece, 29′ 3″, 16′ and 14′, butted and cleated | 30 | |
| 1 piece, 9′, order 10′ | 10 | |
| Total | 64 | 107 |
| Plates, 3″ × 6″; $1\frac{1}{2}$ ft. B. M., per lin. ft.: | | |
| 4 pieces, each 10′ 6″, order 12′ | | 72 |
| Octagonal post, 6″ × 6″ × 3′ | | 9 |

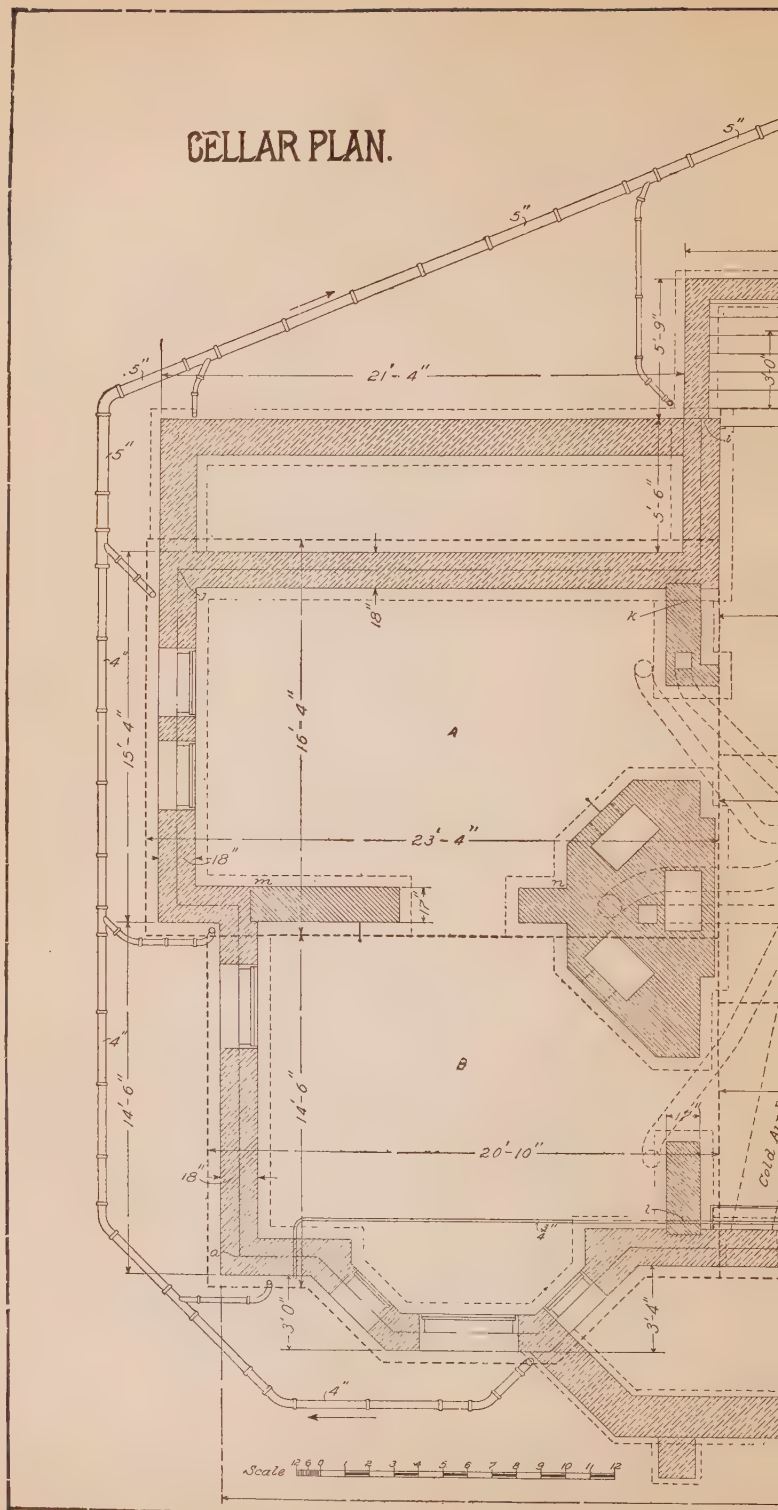
PORCH-ROOF FRAMING

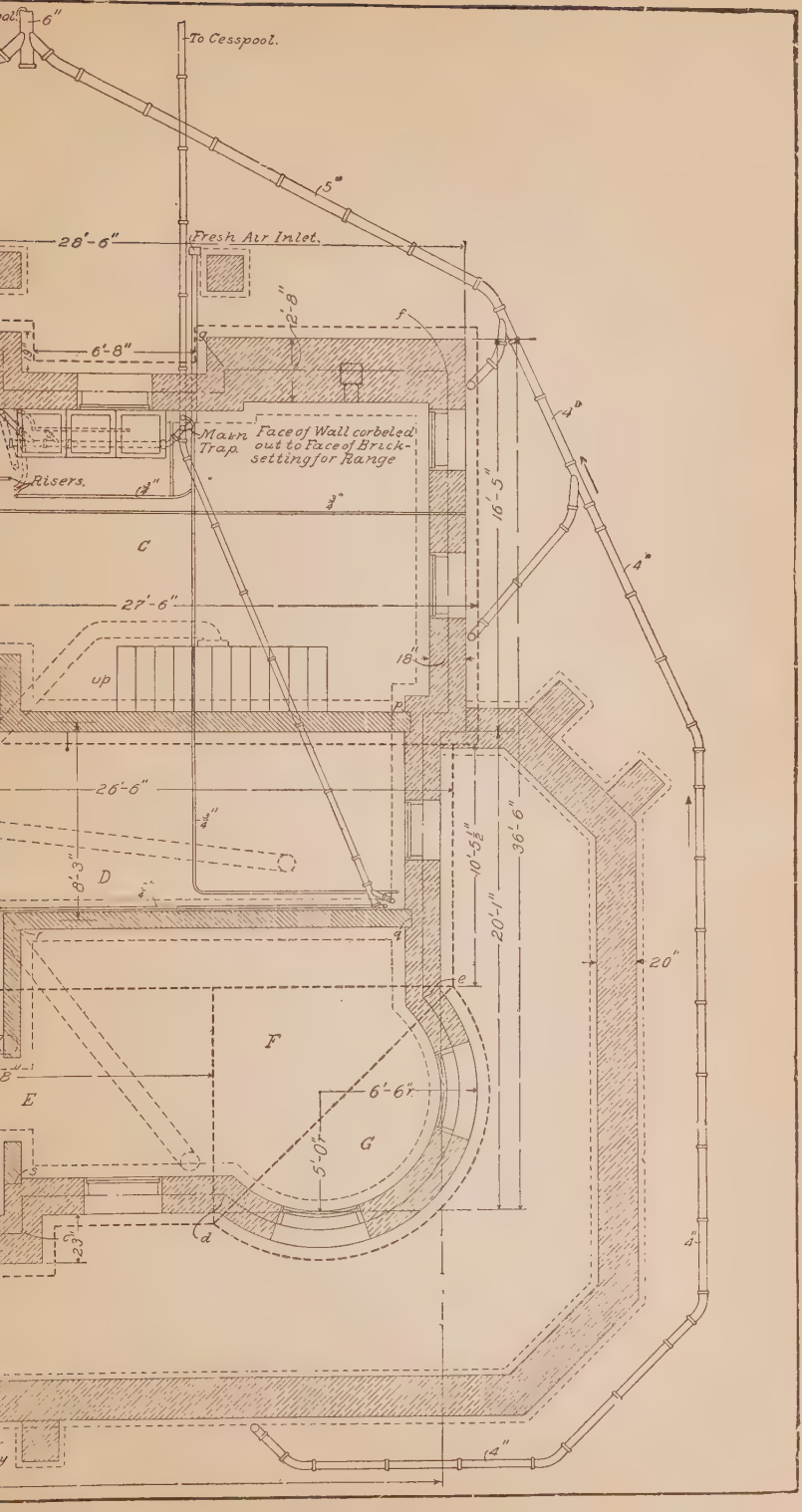
| *Quantities* | LINEAR FEET | FEET B. M. |
|---|---|---|
| Rafters, 2″ × 6″; 1 ft. B. M., per lin. ft.: | | |
| 2 pieces, each 9′ 6″, order 10′ | 20 | |
| 22 pieces, each 8′ 6″, order 10′ | 220 | |
| 4 pieces, each 6′ 6″, cut out of 14′ | 28 | |
| 8 pieces, each 7′, cut out of 14′ | 56 | |
| 2 pieces, each 11′, order 12′ | 24 | |
| Total | 348 | 348 |
| Rafters, 2″ × 5″; $\frac{5}{6}$ ft. B. M., per lin. ft.: | | |
| 27 pieces, each 8′, cut out of 16′ | 216 | |
| 2 pieces, each 3′ 6″, cut out of 16′ | 8 | |
| 8 pieces, each 6′ 6″, cut out of 14′ | 56 | |
| 2 pieces, each 10′ 6″, cut out of 14′ | 21 | |
| 2 pieces each, 3′, cut out of 14′ | 6 | |
| Total | 307 | 256 |
| Plate, 5″ × 10″; $4\frac{1}{6}$ ft. B. M., per lin. ft.: | | |
| 5 pieces, each 15′, order 16′ | 80 | 333 |
| Sills, 3″ × 5″; $1\frac{1}{4}$ ft. B. M., per lin. ft.: | | |
| 2 pieces, each 10′, order 10′ | 20 | |
| 5 pieces, each 9′, order 10′ | 50 | |
| Total | 70 | 88 |

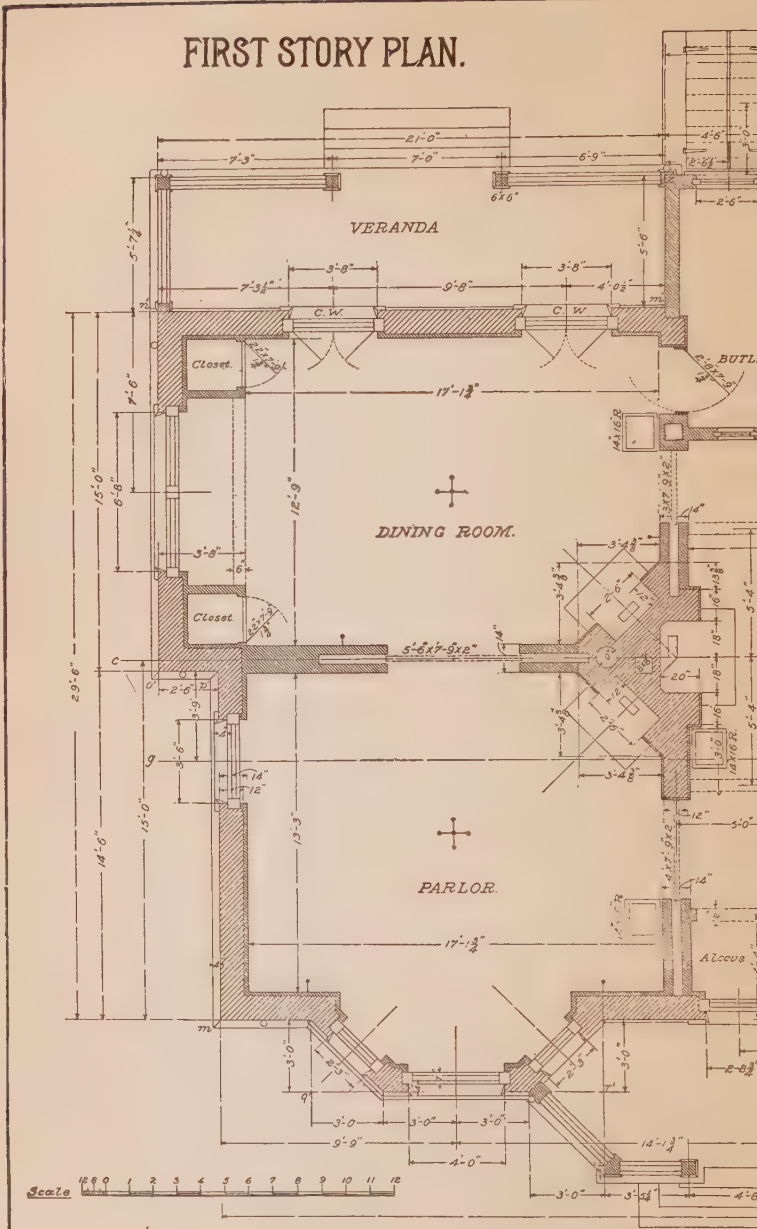
WALL STUDDING

| *Quantities* | LINEAR FEET | FEET B. M.* |
|---|---|---|
| Wall plates,* 4″ × 11″; $3\frac{2}{3}$ ft. B. M., per lin. ft.: | | |
| 10 pieces, each 18′, order 18′ | 180 | 660 |
| Studs, 2″ × 5″; $\frac{5}{6}$ ft. B. M., per lin. ft.: | | |
| *63 pieces, each 21′, order 22′ | 1,386 | |
| 106 pieces, each 12′, order 12′ | 1,272 | |
| 20 pieces, each 20′, order 20′ | 400 | |
| 10 pieces, each 8′ 6″, order 10′ | 100 | |
| Total | 3,158 | 2,632 |

*Where studs over 20 feet are required, it is sometimes more economical to use two short studs, inserting a plate over the first-story studs and resting the feet of the second-story studs thereon.


CELLAR PLAN.
5"
21'-4"
5'-9"
5'-6"
18"
k
A
19'-4"
15'-4"
23'-4"
B
14'-6"
20'-10"
4"
3'-0"
3'-4"
Scale


6"
To Cesspool.
5"
28'-6"
Fresh Air Inlet.
2'-8"
6'-8"
Main Trap
Face of Wall corbeled out to Face of Brick-setting for Range
Risers.
3"
C
16'-5"
4"
27'-6"
18"
up
26'-6"
D
10'-5½"
36'-6"
20'-1"
20"
F
E
6'-6"
5'-0"
G
4"
4"




160–I L T 32B, 308, 333, 346 § 61

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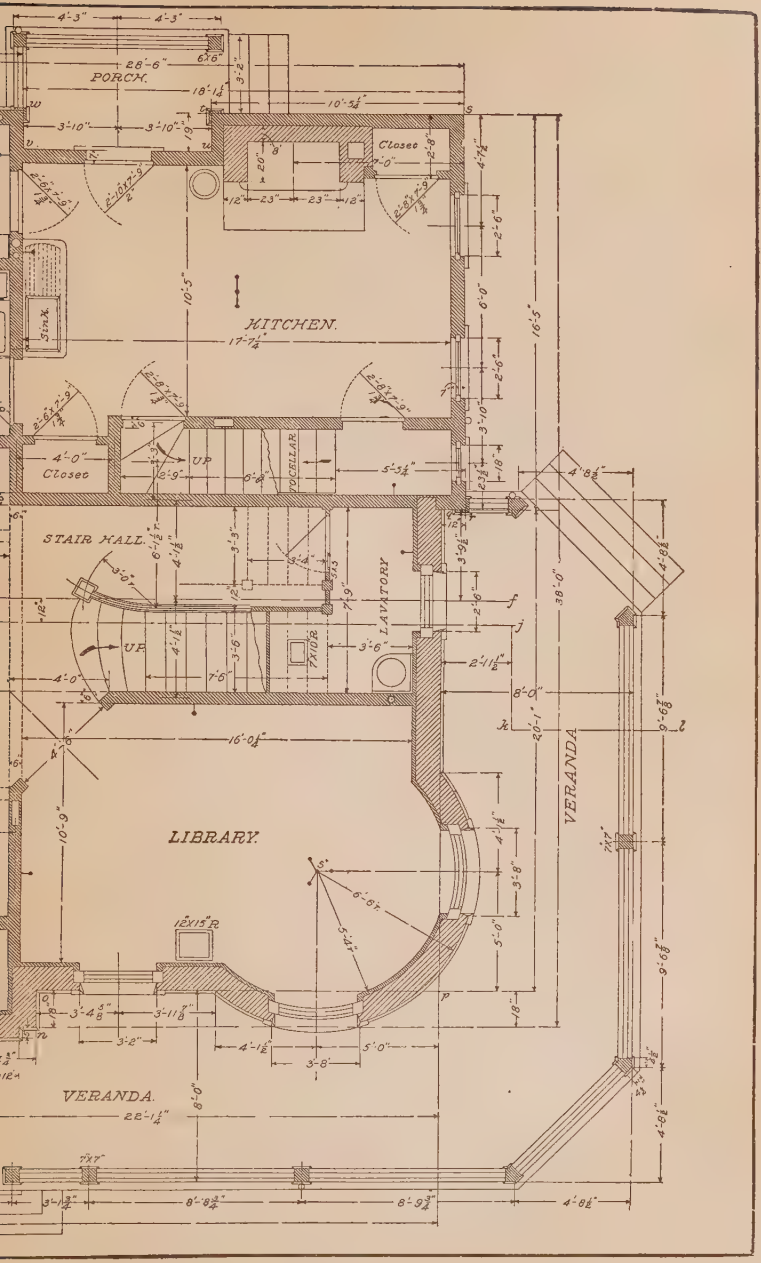


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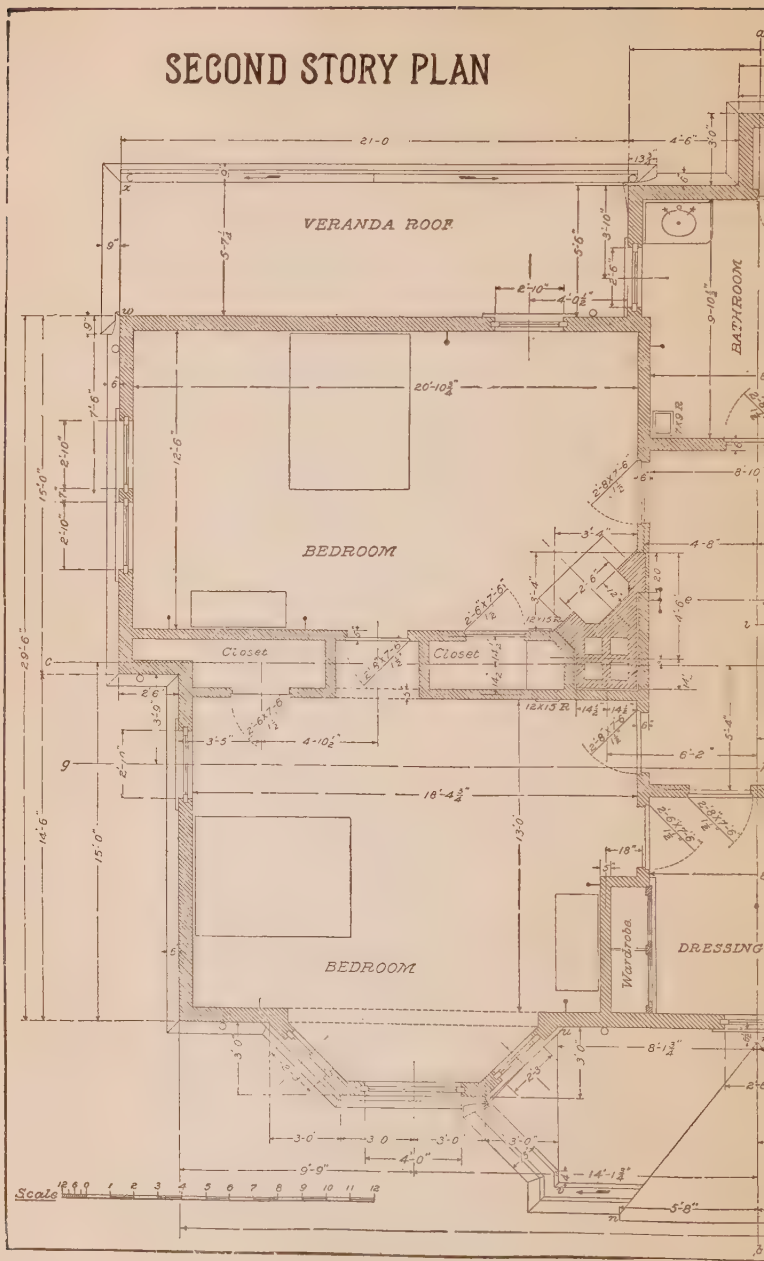
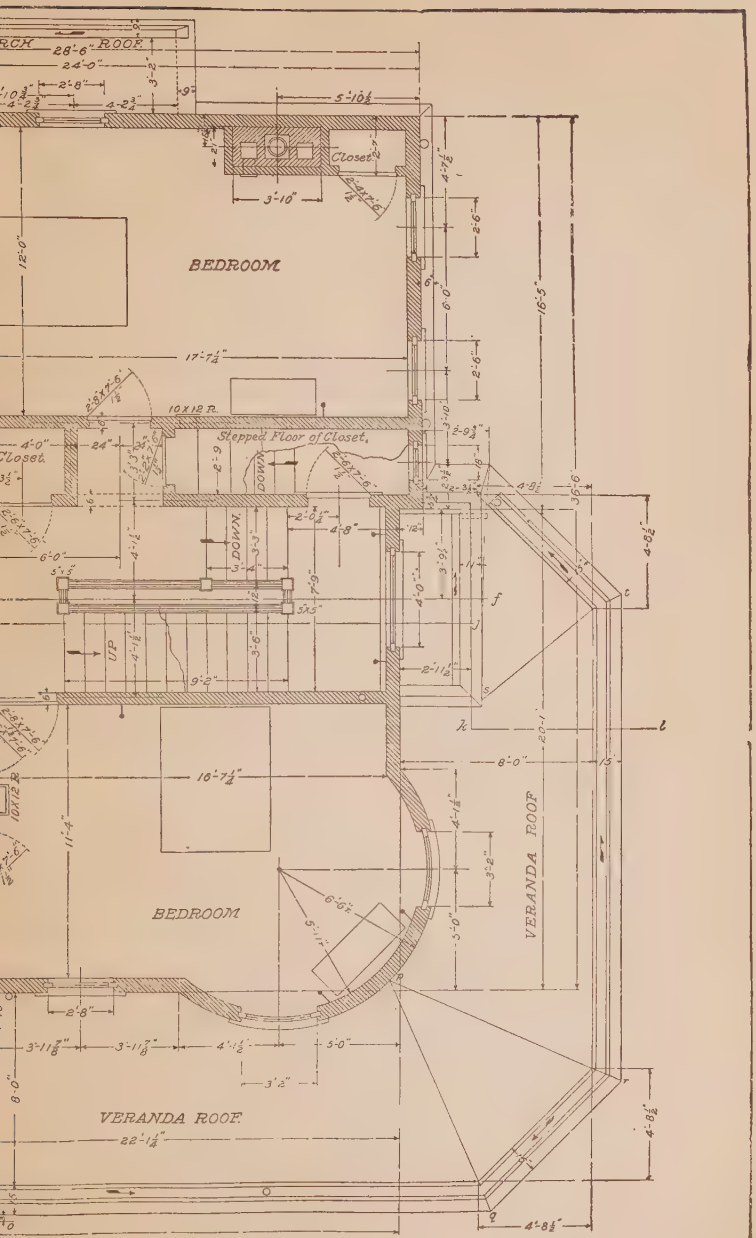
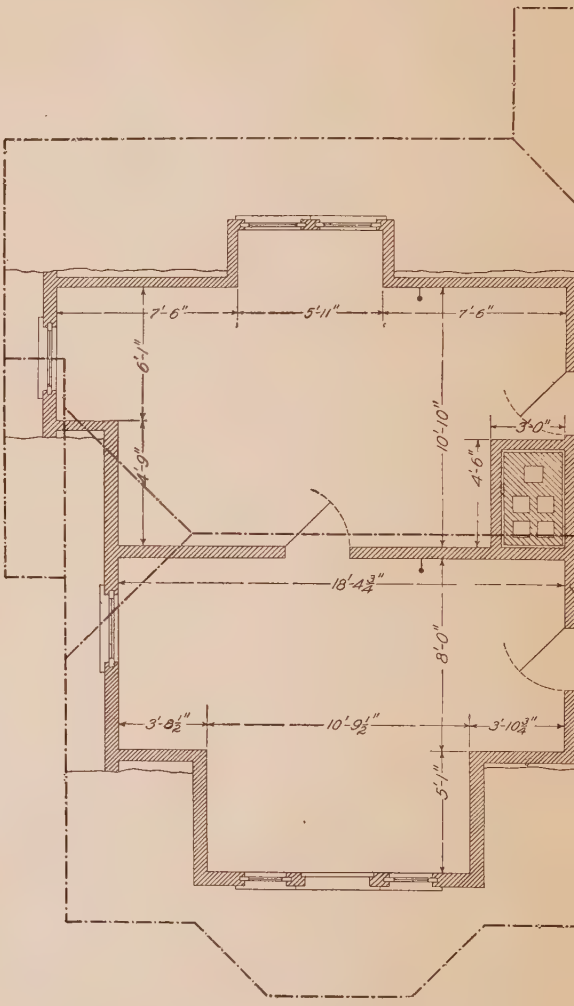



160-I L T 32B, 308, 333, 346 § 61

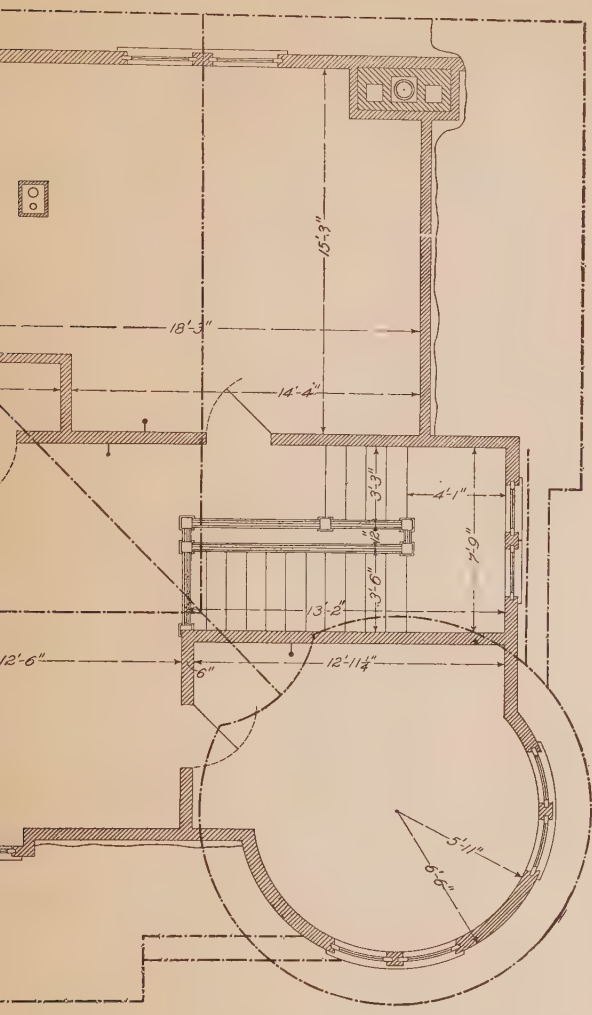
Copyright, 1895, 1899

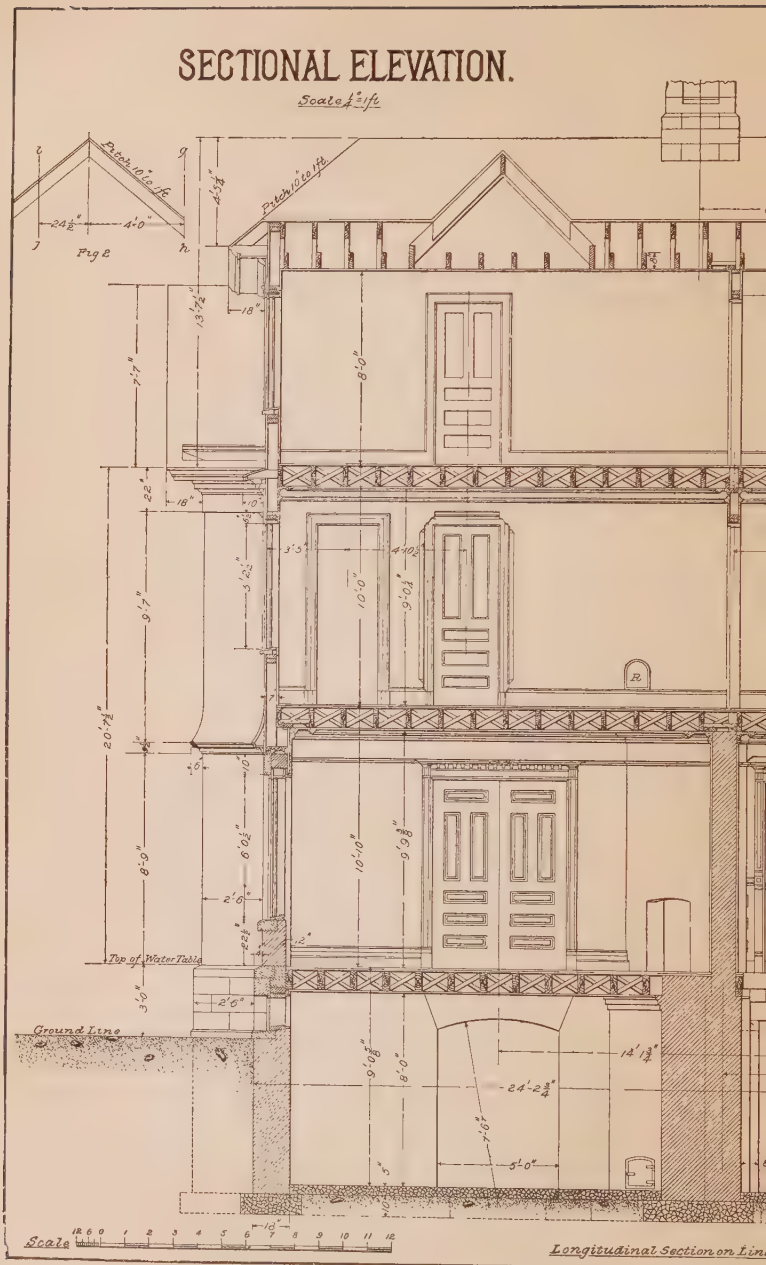

BEDROOM
Closet
Stepped Floor of Closet.
WINDOW
WINDOW
UP
BEDROOM
VERANDA ROOF
VERANDA ROOF
28'-6" ROOF
24'-0"
5'-10½"
3'-10"
17'-7¼"
16'-7¼"
22'-1¼"
10X12 R.
10X12 R.
5X5
f
l
λ

# ATTIC PLAN.




160–I L T 32B, 308, 333, 346 § 61


15'-3"
18'-3"
14'-4"
3'-3"
4'-1"
2'-0"
3'-6"
13'-2"
12'-6"
6"
12'-11¼"
5'-11"
6'-6"




160–I L T 32B, 308, 333, 346 § 61

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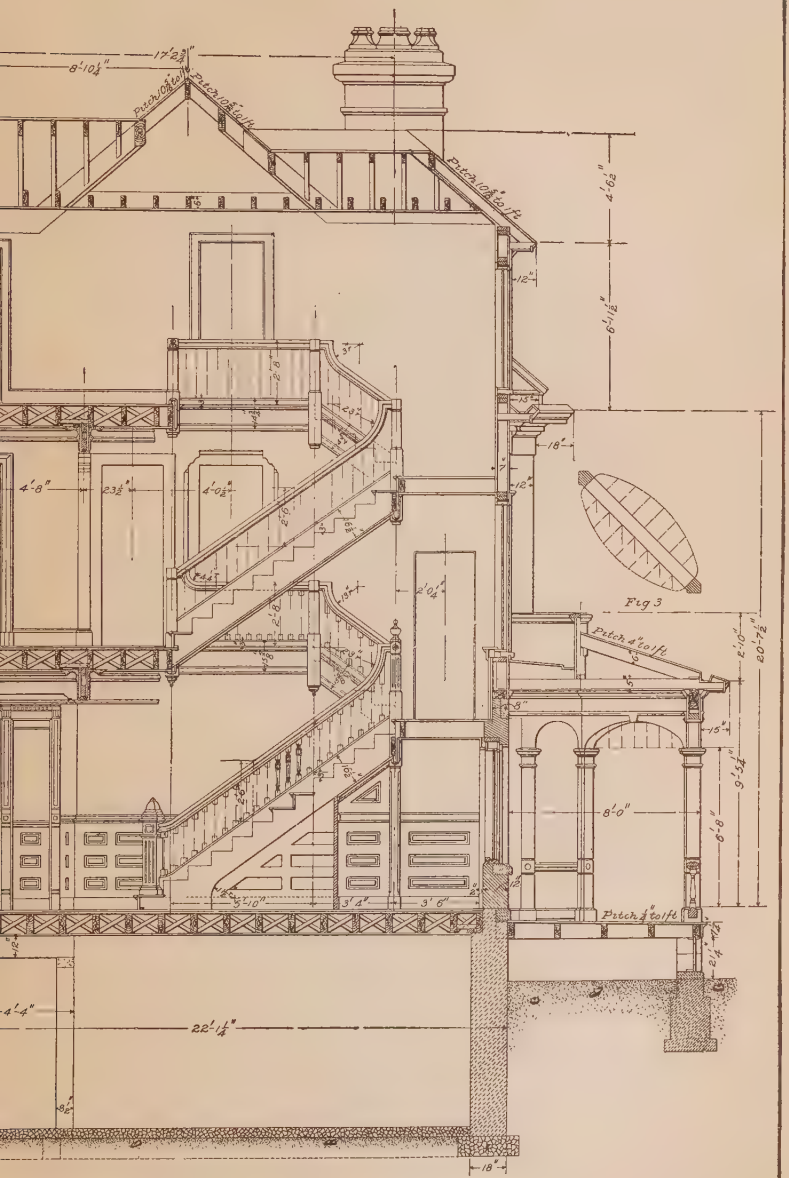


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160–I L T 32B, 308, 333, 346 § 61

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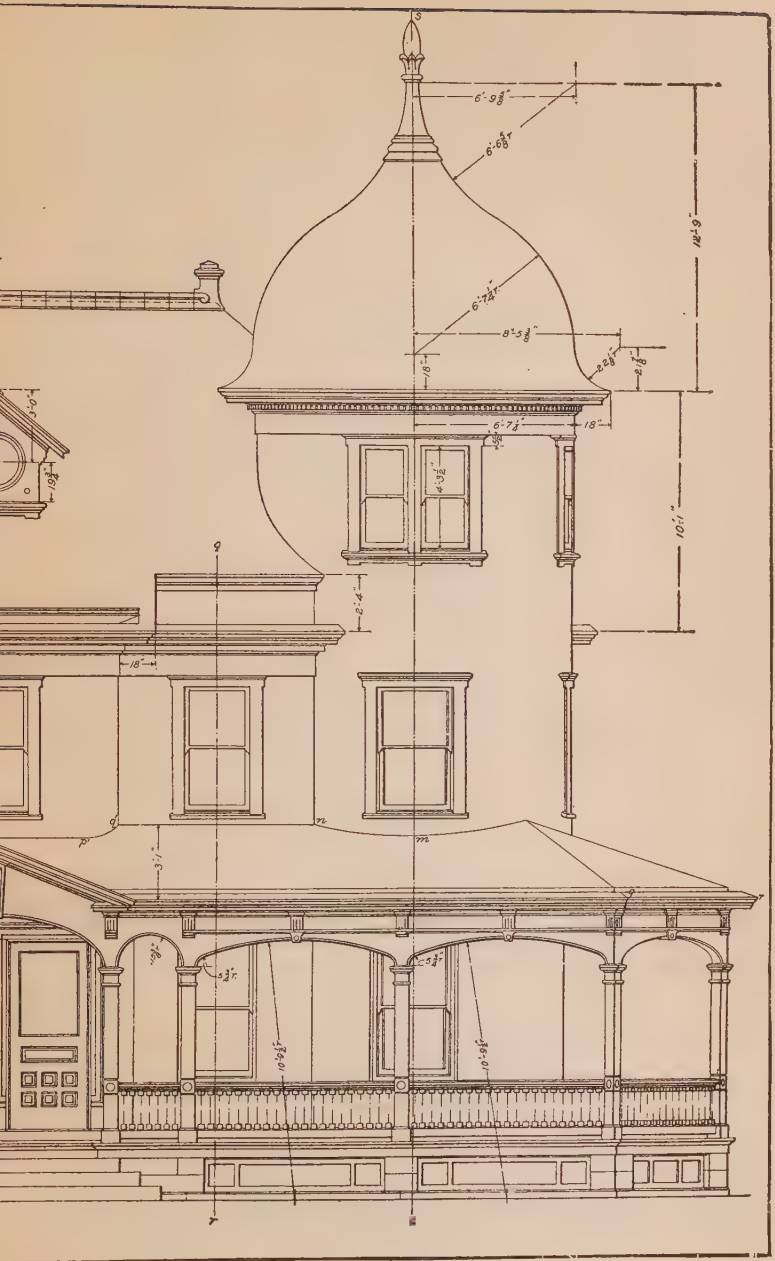


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PARTITION STUDDING

| *Quantities* | LINEAR FEET | FEET B. M. |
|---|---|---|
| First floor, $2'' \times 4''$; $\frac{2}{3}$ ft. B. M., per lin. ft.: | | |
| Studs, 160 pieces, each 9′ 9″, order 10′ . | 1,600 | |
| Sills, 16 pieces, each 15′, order 16′ . . . | 256 | |
| Total . . . . . | 1,856 | 1,237 |
| Second floor, $2'' \times 4''$; $\frac{2}{3}$ ft. B. M., per lin. ft.: | | |
| Studs, 180 pieces, each 9′ 9″, order 10′ . | 1,800 | |
| Sills, 10 pieces, each 15′, order 16′ . . . | 160 | |
| Total . . . . . | 1,960 | 1,307 |
| Attic, $2'' \times 4''$; $\frac{2}{3}$ ft. B. M., per lin. ft.: | | |
| Studs, 54 pieces, each 8′ 9″, order 10′ . . | 540 | |
| Studs, 133 pieces, each 6′ 6″, cut from 14′ | 938 | |
| Total . . . . . | 1,478 | 985 |

MISCELLANEOUS

| *Quantities* | LINEAR FEET | FEET B. M. |
|---|---|---|
| Lookouts: | | |
| 50 pieces, each $3'' \times 1'' \times 2'$, cut from 8′ . | | 25 |
| 37 pieces, each $6'' \times 1'' \times 2'$, cut from 8′ . | | 37 |
| Furring, for brick walls, $1'' \times 2''$; $\frac{1}{6}$ ft. B. M., per lin. ft.: | | |
| 125 pieces, each 11′, order 12′ . . . . . | 1,500 | 250 |
| Grand total of framing . . . . . | | 18,578 |

*Cost*

The price of the framing is based on the following cost of 1,000 feet board measure of hemlock, which includes framing.

| | |
|---|---|
| 1,000 ft. of hemlock . . . . . | $28.00 |
| Nails and spikes, allowing 100 lb. to 3,000 ft. of lumber, at $2 per 100 pounds . . . . . | .67 |
| *Cost of framing, per 1,000 feet of lumber . . . . | 12.00 |
| Cost per thousand feet B. M. . . . . | $40.67 |

*This value would appear high if compared with Table VI, *Estimating and Calculating Quantities*, Part 1, but this table represents ideal conditions, where there are no delays, mistakes, legitimate office expenses, nor foreman's time included.

*Summary*

The amount of material, as previously estimated, is 18,578 ft. B. M., which, at $40.67 per M, will make the total cost of framing $755.57.

SHEATHING

*Quantities*

| | Feet B. M. |
|---|---|
| Main roof, 2,200 sq. ft. × 1 in. | 2,200 |
| Tower roof, 370 sq. ft. × 1 in. | 370 |
| Porch roof, 637 sq. ft. × 1 in. | 637 |
| Outside walls, laid diagonally, 2,417 sq. ft. + 10 per cent. | 2,659 |
| Total sheathing | 5,866 |

SHINGLES

*Quantities*

Area to be covered (see wall sheathing), 2,417 sq. ft. = 24.2 squares

| | |
|---|---|
| Shingles, 4 in. wide, and 5 in. exposure, number per square . . . . . 720 | |
| Number of shingles required, 24.2 × 720 | 17,424 |
| Add 5 per cent. for waste | 871 |
| Total shingles | 18,295 |

*Cost*

The cost of sheathing in place is assumed to be the same as that for hemlock lumber, $40.67 per M. The total sheathing is 5,866 square feet, which, at $40.67 per M, will make the cost of sheathing $238.57.

The cost of shingles is based on the following analysis of the cost of 1,000 shingles in place:

| | |
|---|---|
| 1,000 shingles XXXX | $5.50 |
| *Labor: one man can lay about 700 shingles per day; wages being $3.20, 1,000 will cost | 4.57 |
| Nails (about) | .25 |
| Cost per thousand | $10.32 |

*Usually a man can lay more than 700 shingles per day, but the roof under consideration is very much cut up.

From the preceding estimate, the number of shingles required is 18,295, which, at $10.32 per 1,000, will make the cost of shingles in place $188.80.

*Summary*

| | |
|---|---|
| Sheathing | $238.57 |
| Shingles | 188.80 |
| Total cost of sheathing and shingles | $427.37 |

FLOORING

*Quantities*

| | Square Feet |
|---|---|
| First floor, area (net) | 1,312 |
| Second floor, area (net) | 1,312 |
| Attic floor, area (net) | 1,071 |
| Porch floors, area (net) | 523 |

HEMLOCK UNDERFLOORING

Unmatched underflooring is used under the first and second floor. Its quantity is $1{,}312 \times 2 = 2{,}624$ feet B. M.

RIFT-SAWED YELLOW-PINE FINISH FLOORING

The total area of the first, second, and third floors is 3,695 square feet. Adding 25 per cent. for waste, the quantity of $\frac{7}{8}$-inch flooring is 3,695 square feet + $(3{,}695 \times .25) = 4{,}619$ feet B. M.

YELLOW-PINE PORCH FLOORING

Increasing the net area of the porch floor by 25 per cent., the flooring required is 523 square feet + $(523 \times .25) = 654$ feet B. M.

*Cost*

The estimated cost of flooring may be analyzed as follows:

*Cost of 1,000 Feet B. M., Rough Flooring*

| | |
|---|---|
| *1,000 ft. B. M., hemlock | $27.00 |
| Labor | 10.00 |
| Nails, 33 lb., at $2 per 100 pounds | .67 |
| Cost per thousand feet B. M. | $37.67 |

*The cost of this hemlock is $1 cheaper per thousand than that used in the framing, since shorter lengths may be employed.

*Cost of 1,000 Feet B. M., Finish Flooring*

| | |
|---|---|
| 1,000 ft. B. M., rift-sawed yellow pine | $55.00 |
| Labor, including striking joints | 16.00 |
| Nails | .67 |
| Cost per thousand feet B. M. | $71.67 |

*Cost of 1,000 Feet B. M., Porch Flooring*

| | |
|---|---|
| 1,000 ft. B. M., No. 1 yellow pine | $45.00 |
| Labor | 16.00 |
| White lead for joints (about) | .50 |
| Nails | .67 |
| Cost per thousand feet B. M. | $62.17 |

*Summary*

| | |
|---|---|
| Hemlock, 2,624 ft. B. M., at $37.67 per M | $98.85 |
| Rift-sawed yellow pine, 4,619 ft. B. M., at $71.67 per M | 331.04 |
| Yellow pine, 654 ft. B. M., at $62.17 per M | 40.66 |
| Total cost of flooring | $470.55 |

PORCH CEILING, YELLOW PINE

*Quantities*

| | Feet B. M. |
|---|---|
| Porch ceiling, same as porch flooring | 654 |

*Cost*

The cost of yellow-pine ceiling is $45 per thousand feet B. M. Since there is no white lead to be used and the joints are not struck, $11 will pay for laying it. The nails will cost 67 cents, which will bring the cost per thousand feet B. M., up to $56.67. Therefore, 654 feet B. M., yellow-pine ceiling, at $56.67 per thousand, will cost $37.06.

CORNICE, SPANDRELS, ETC., WHITE-PINE DRESSED LUMBER

*Cost*

| | |
|---|---|
| Cornice, 393 lin. ft., at 50 cents per foot | $196.50 |
| Spandrels, 357 lin. ft., at 12 cents per foot | 42.84 |
| Base, 128 lin. ft., at 6 cents per foot | 7.68 |
| 16 porch posts, 8″ × 8″ × 9′ at $4 each | 64.00 |
| Total | $311.02 |

*Summary*

| | |
|---|---|
| Yellow-pine ceiling | $ 37.06 |
| White-pine dressed lumber | 311.02 |
| Total | $348.08 |

*Recapitulation of Cost of Carpentry*

| | |
|---|---|
| Framing | $755.57 |
| Sheathing and shingles | 427.37 |
| Flooring | 470.55 |
| Porch ceiling, cornice, etc. | 348.08 |
| Total cost of carpentry | $2,001.57 |

## ROOFING

**6.** Roof framing and sheathing are included in the estimate for carpentry. Following are given the estimates for slating and miscellaneous roof items:

SLATING

*Quantities*

| | SQUARES |
|---|---|
| Main and dormer roofs | 22.0 |
| Porch roof | 6.4 |
| Tower roof | 3.7 |
| | 32.1 |

*Cost*

The price of slating per square is given in Table XII, *Estimating and Calculating Quantities*, Part 1. Bangor slating costs $8 per square. On account of the curved tower and the number of hips and valleys, and because the measurement just given is actual measurement, the price will be put at $10 per square. Thus, the cost of 32.1 squares at $10 will be $321.

MISCELLANEOUS ITEMS*

*Quantities and Cost*

| | |
|---|---|
| Tin roof on bay window, 38 sq. ft. at 20 cents per square foot | $ 7.60 |
| Tin for valleys, 191 sq. ft., at 18 cents per square foot | 34.38 |

*The prices given include the cost of labor.

| | |
|---|---|
| Flashing around chimneys and dormers, 90 sq. ft., at 10 cents per square foot | $ 9.00 |
| Gutters, 100 lin. ft., 26 in. wide, at 28 cents per foot | 28.00 |
| Conductor pipe, 4-inch galvanized iron, 146 lin. ft., at 20 cents per linear foot | 29.20 |
| Terra-cotta ridge tiles, 70 lin. ft., at $1 per linear foot | 70.00 |
| 3 terra-cotta finials, 2 ft. high, at $8 each | 24.00 |
| Tower finial, copper | 30.00 |
| Total | $232.18 |

*Recapitulation of Cost of Roofing*

| | |
|---|---|
| Slating | $321.00 |
| Miscellaneous | 232.18 |
| Total cost of roofing | $553.18 |

## LATHING AND PLASTERING

**7.** Plastering varies in price according to its position and quality. It is therefore necessary to make a separate schedule of each class of work, so that any increase or decrease in quantity may be easily added to or deducted from the estimate.

THREE-COAT WORK

| *Quantities* | SQUARE FEET | SQUARE YARDS |
|---|---|---|
| First-story walls, $542' \times 9'\ 9\frac{3}{8}''$ | 5,284.5 | |
| First-story ceiling (take measurement of flooring) | 1,312.0 | |
| Second-story walls, $609' \times 9'$ | 5,481.0 | |
| Second-story ceiling | 1,312.0 | |
| Attic walls, $190' \times 8' + 156' \times 6'$ | 2,456.0 | |
| Attic ceiling | 831.0 | |
| Total of three-coat plastering | 16,676.5 | 1,853 |

TWO-COAT WORK

| *Quantities* | SQUARE FEET | SQUARE YARDS |
|---|---|---|
| Cellar ceiling, use same measurements as for concrete cellar floor | | 139.9 |

CORNICES

| *Quantities* | LINEAR FEET |
|---|---|
| Cornice, 147′ of 2′ girth | 147 |
| Cornice, 493′ of 1′ girth | 493 |

*Cost*

The cost of three-coat plastering is given in *Estimating and Calculating Quantities*, Part 1, as 31 cents per square yard, and two-coat work, as 23 cents per square yard. According to the same section, lathing costs 12 cents per square yard. Therefore, lathing and plastering for three-coat work cost 43 cents per square yard, and for two-coat work, 35 cents per square yard.

The assumed cost of plain, run stucco cornice per linear foot of 2-foot girth is 31½ cents, and the cost per linear foot of that having a 1-foot girth is 27 cents.

*Summary*

From the preceding estimates of quantities and costs, the following figures are obtained:

| | |
|---|---|
| 1,853 sq. yd. of three-coat work, at 43 cents per square yard | $ 796.79 |
| 139.9 sq. yd. of two-coat work, at 35 cents per square yard | 48.97 |
| 147 ft. of cornice at 31½ cents | 46.31 |
| 493 ft. of cornice at 27 cents | 133.11 |
| Total cost of plastering | $1,025.18 |

## JOINERY

**8.** As there are so many different sizes in the joinery work, no attempt has been made to make detailed estimates of the cost of each; but the general method of obtaining the costs is that given in the articles on Joinery, in *Estimating and Calculating Quantities*, Part 1. Since the quality of the work varies in different parts of the building it will be found that one unit price will not be sufficient, but experience is needed to fix the unit price for different classes of work.

### Door Frames, First Floor

*Quantities and Cost*

Chestnut frames—jambs $1\frac{1}{8}''$ rabbeted; casing $\frac{7}{8}'' \times 5\frac{1}{2}''$, with $\frac{1}{4}$-inch edge mold; back-band molding $\frac{7}{8}'' \times 2''$; plinth and corner blocks:

| | |
|---|---|
| 1 frame, 3′ 2″ × 7′ 9″ × 6″ (vestibule) | $ 4.16 |
| 1 frame, 3′ 2″ × 7′ 9″ × 9″ (3-inch jamb), front door | 4.68 |
| 1 frame, 5′ 6″ × 7′ 9″ × 14″ (sliding door) | 13.60 |
| 1 frame, 4′ × 7′ 9″ × 14″ (sliding door) | 9.35 |
| 1 frame, 3′ × 7′ 9″ × 14″ (sliding door) | 6.80 |
| 2 frames, 2′ 8″ × 7′ 9″ × 6″, $4.16 each | 8.32 |
| 2 frames, 22″ × 7′ 9″ × 4″, $2.21 each | 4.42 |

White pine—jambs 6″ × $1\frac{1}{8}''$ rabbeted; casings $\frac{7}{8}'' \times 5''$; back-band molding $2'' \times \frac{7}{8}''$; plinth and corner blocks:

| | |
|---|---|
| 4 frames, 2′ 8″ × 7′ 9″, $3.70 each | 14.80 |
| 2 frames, 2′ 6″ × 7′ 9″, $3.61 each | 7.22 |
| 1 frame, 2′ 10″ × 7′ 9″ | 3.78 |
| Total | $77.13 |

### Door Frames, Second Floor

*Quantities and Cost*

White pine, similar to first floor:

| | |
|---|---|
| 8 frames, 2′ 8″ × 7′ 6″, $3.57 each | $28.56 |
| 6 frames, 2′ 6″ × 7′ 6″, $3.50 each | 21.00 |
| 1 frame, 2′ 2″ × 7′ 6″ | 3.19 |
| 1 frame, 2′ 4″ × 7′ 6″ | 3.40 |
| 1 frame, 2′ 6″ × 7′ | 3.19 |
| Total | $59.34 |

### Door Frames, Attic

*Quantities and Cost*

White pine, similar to second-floor doors:

| | |
|---|---|
| 6 frames, 2′ 8″ × 6′ 8″ at $3.19 | $19.14 |
| 1 frame, 2′ 6″ × 6′ 6″ | 3.06 |
| Total | $22.20 |

*Summary*

| | |
|---|---|
| First floor | $ 77.13 |
| Second floor | 59.34 |
| Attic | 22.20 |
| Total cost of door frames | $158.67 |

DOORS, FIRST STORY*

*Quantities and Cost*

| | |
|---|---|
| Veneered chestnut, six and seven raised panels, planted moldings: | |
| 1 pair sliding, 2′ 9″ × 7′ 9″ × 2″ | $ 15.90 |
| 1 single sliding, 4′ × 7′ 9″ × 2″ | 11.34 |
| 1 single sliding, 3′ × 7′ 9″ × 2″ | 8.97 |
| 1 lavatory, 2′ 4″ × 6′ × 1¾″ (frame included in paneling) | 4.93 |
| 2 closet doors, 22″ × 7′ 9″ × 1¾″, solid molded, including glass in upper panel, at $5 each | 10.00 |
| 1 front door, 3′ 2″ × 7′ 9″ × 2¼″, three-panel, glass in top panel, price, including glass | 12.75 |
| 1 vestibule door, 3′ 2″ × 7′ 9″ × 2¼″, three-panel, glass in top panel, price, including glass | 12.75 |
| Veneered chestnut and pine doors: | |
| 1 in butler's pantry, 2′ 8″ × 7′ 9″ × 2″ | 7.50 |
| 1 in butler's pantry, 2′ 8″ × 7′ 9″ × 1¾″ | 6.71 |
| White-pine doors, raised panels: | |
| 2 glass doors, 2′ 4″ × 5′ × 1¼″, one-panel, at $3 (china closet, no frames) | 6.00 |
| 4 doors, 2′ 8″ × 7′ 9″ × 1¾″, five-panel, solid moldings, at $4.13 each | 16.52 |
| 2 doors, 2′ 6″ × 7′ 9″ × 1¾″, five-panel, solid moldings, at $3.91 each | 7.82 |
| 1 door, 2′ 10″ × 7′ 9″ × 2″, five-panel, solid molded | 6.59 |
| 2 outside cellar doors, at $2 each | 4.00 |
| Total | $131.78 |

* The prices of doors do not include hardware, which item will be found in the hardware bill, but they include putting on the hardware.

### Doors, Second Floor

*Quantities and Cost*

| | |
|---|---|
| $1\frac{1}{2}$-inch white pine, five-panel, solid molded, raised panels: | |
| 8 doors, 2′ 8″ × 7′ 6″, at $4 | $32.00 |
| 6 doors, 2′ 6″ × 7′ 6″, at $3.75 | 22.50 |
| 1 door, 2′ 6″ × 3′ 6″ | 1.75 |
| 1 door, 2′ 2″ × 7′ 6″ | 3.20 |
| 1 door, 2′ 4″ × 7′ 6″ | 3.40 |
| 2 wardrobe doors, 2′ 2″ × 6′ × $1\frac{1}{4}$″, including glass panels, at $2 each | 4.00 |
| Total | $66.85 |

### Doors, Attic

*Quantities and Cost*

| | |
|---|---|
| White pine, similar to second floor: | |
| *1 stuck-molded door, 2′ 6″ × 6′ 6″, glass panel | $ 4.70 |
| 6 doors, 2′ 8″ × 6′ 8″, at $3.60 | 21.60 |
| Total | $ 26.30 |

*Summary*

| | |
|---|---|
| First story | $131.78 |
| Second story | 66.85 |
| Attic | 26.30 |
| Total cost of doors | $224.93 |

### Window Frames, Cellar

*Quantities and Cost*

| | |
|---|---|
| No. 2 white pine, $1\frac{1}{2}$″ × 7″ rabbeted jambs and head, and 2″ × 7″ sill. Complete, set in place: | |
| 1 window, 3 lights, 13″ × 10″ | $ 1.16 |
| 2 windows, 1 light, 16″ × 10″, at 48 cents each | .96 |
| 4 windows, 2 lights, 14″ × 10″, at 83 cents each | 3.32 |
| 3 windows, 2 lights, 11″ × 10″, at 66 cents each | 1.98 |
| 2 windows, 2 lights, 13″ × 10″, at 78 cents each | 1.56 |
| 1 window, 3 lights, 11″ × 10″ | .99 |
| Total | $ 9.97 |

*This door opens to the balcony.

### Window Frames, First Story

*Quantities and Cost*

Box frames, pulley stiles and hanging stiles $1\frac{1}{8}''$, sills $2''$, and outer casing $\frac{7}{8}''$, all of No. 2 white pine. Inside casing chestnut, with molded back band $5\frac{1}{2}'' \times \frac{7}{8}''$, stool $4'' \times 1\frac{1}{8}''$, apron $5'' \times \frac{7}{8}''$, sash stop $\frac{1}{2}'' \times 1\frac{1}{2}''$.

Frames in brickwork. Complete, set in place:

| | |
|---|---|
| 1 window, 2 lights, $40'' \times 32''$ | $ 7.80 |
| 2 windows, 2 lights, $18'' \times 32''$, at $3.16 each | 6.32 |
| 1 window, 2 lights, $24'' \times 32''$ | 4.18 |
| 1 window, 2 lights, $34'' \times 32''$ | 5.88 |
| 2 windows, 2 lights, $36'' \times 32''$, curved, at $12.24 | 24.48 |
| 1 window, 2 lights, $30'' \times 32''$ | 5.10 |
| 1 window, 2 lights, $22'' \times 24''$ | 2.80 |
| 1 window, 4 lights, $31'' \times 32''$ (double) | 10.55 |
| 2 windows, 6 lights, $15'' \times 28''$ (casement), at $6.70 | 13.40 |
| Total | $80.51 |

Pulley stiles $1\frac{1}{8}''$, sill $2''$, sub-sills $1\frac{1}{8}''$, outside casings $\frac{7}{8}''$, inside casing with molded back band $5\frac{1}{2}'' \times \frac{7}{8}''$, stool $4'' \times 1\frac{1}{8}''$, apron $5'' \times \frac{7}{8}''$, sash stop $\frac{1}{2}'' \times 1\frac{1}{2}''$, all of white pine.

Frames in wooden walls. Complete, set in place:

| | |
|---|---|
| 1 window, single light, $14'' \times 28''$ | $ 1.04 |
| 3 windows, 2 lights, $26'' \times 32''$, at $4.42 each | 13.26 |
| 1 window, 2 lights, $22'' \times 32''$ | 3.74 |
| Total | $18.04 |

### Window Frames, Second Story

*Quantities and Cost*

| | |
|---|---|
| 1 window, single light, $14'' \times 28''$ | $ 1.04 |
| 2 windows, 2 lights, $44'' \times 28''$, at $6.54 each | 13.08 |
| 2 windows, 2 lights, $23'' \times 28''$, at $3.40 each | 6.80 |
| 3 windows, 2 lights, $28'' \times 28''$, at $4.18 each | 12.54 |
| 2 windows, 2 lights, $36'' \times 28''$ (curved), at $10.72 each | 21.44 |
| 3 windows, 2 lights, $26'' \times 28''$, at $3.90 each | 11.70 |
| 1 window, 2 lights, $20'' \times 28''$ | 2.98 |
| 4 windows, 2 lights, $30'' \times 38''$, at $6.07 each | 24.28 |
| Total | $93.86 |

WINDOW FRAMES, ATTIC

*Quantities and Cost*

| | |
|---|---|
| 2 windows, 2 lights, 18″ × 18″, at $1.69 each | $ 3.38 |
| 1 window (circular), 24″ diameter | 2.27 |
| 2 double windows, 4 lights, 22″ × 24″ (curved), at $11.22 each | 22.44 |
| 1 double window, 4 lights, 21″ × 24″ | 5.35 |
| 1 double window, 4 lights, 28″ × 20″ | 5.96 |
| 1 double window, 4 lights, 24″ × 20″ | 5.10 |
| 1 window, 2 lights, 28″ × 20″ | 2.98 |
| 1 window, 2 lights, 30″ × 28″ | 4.46 |
| Total | $51.94 |

*Summary*

| | |
|---|---|
| Cellar | $ 9.97 |
| First story in brick walls | 80.51 |
| First story in frame | 18.04 |
| Second story | 93.86 |
| Attic | 51.94 |
| Total cost of window frames | $254.32 |

WINDOW SASH, CELLAR

*Quantities and Cost*

1½-inch white pine, glazed (double American), price not including hardware:

| | |
|---|---|
| 1 sash, 3 lights, 13″ × 10″ | $ 1.14 |
| 2 sashes, single light, 16″ × 10″, at 47 cents each | .94 |
| 4 sashes, 2 lights, 14″ × 10″, at 82 cents each | 3.28 |
| 3 sashes, 2 lights, 11″ × 10″, at 64 cents each | 1.92 |
| 2 sashes, 2 lights, 13″ × 10″, at 76 cents each | 1.52 |
| 1 sash, 3 lights, 11″ × 10″ | .96 |
| Total | $ 9.76 |

WINDOW SASH, FIRST STORY

*Quantities and Cost*

Chestnut, 1¾ inch, prices including glazing (double American), hanging sash, and putting on stops:

| | |
|---|---|
| 1 pair, single light, 40″ × 32″ | $ 7.47 |
| 2 pair, single light, 18″ × 32″, at $3.36 per pair | 6.72 |
| 1 pair, single light, 24″ × 32″ | 4.48 |

| | |
|---|---|
| 1 pair, single light, 34″ × 32″ | $ 6.35 |
| 2 pair, single light, 36″ × 32″ (curved), at $20.16 per pair | 40.32 |
| 2 pair, single light, 31″ × 32″, at $5.79 per pair | 11.58 |
| 1 pair, single light, 30″ × 32″ | 5.60 |
| 1 pair, single light, 22″ × 24″ | 3.08 |
| 2 pair, 3 lights, 15″ × 28″ (casement), at $7.35 per pair | 14.70 |
| Pine: | |
| 1 sash, single light, 14″ × 28″ | 1.14 |
| 3 pair, single light, 26″ × 32″, at $4.85 per pair | 14.55 |
| 1 pair, single light, 22″ × 32″ | 4.11 |
| Total | $120.10 |

WINDOW SASH, SECOND STORY

*Quantities and Cost*

| | |
|---|---|
| Pine: | |
| 1 sash, single light, 14″ × 28″ | $ 1.14 |
| 2 pair, single light, 44″ × 28″, at $7.19 per pair | 14.38 |
| 2 pair, single light, 23″ × 28″, at $3.76 per pair | 7.52 |
| 3 pair, single light, 28″ × 28″, at $4.57 per pair | 13.71 |
| 2 pair, single light, 36″ × 28″ (curved), at $17.64 per pair | 35.28 |
| 3 pair, single light, 26″ × 28″, at $4.25 per pair | 12.75 |
| 1 pair, single light, 20″ × 28″ | 3.27 |
| 4 pair, single light, 30″ × 28″, at $4.90 per pair | 19.60 |
| Total | $107.70 |

WINDOW SASH, ATTIC

*Quantities and Cost*

| | |
|---|---|
| 2 pair, single light, 18″ × 18″, at $1.89 per pair | $ 3.78 |
| 1 sash, circular, 24-inch diameter | 2.52 |
| 4 pair, single light, 22″ × 24″ (curved), at $9.24 per pair | 36.96 |
| 2 pair, single light, 21″ × 24″, at $2.94 per pair | 5.88 |
| 3 pair, single light, 28″ × 20″, at $3.27 per pair | 9.81 |
| 2 pair, single light, 24″ × 20″, at $2.80 per pair | 5.60 |
| 1 pair, single light, 30″ × 28″ | 4.90 |
| Total | $ 69.45 |

### Screen Frames for Porch

*Quantities and Cost*

| | |
|---|---|
| Rails and stiles, white pine, 4″ × 1½″, two muntins each: | |
| 1 frame, 36″ × 16″ | $ .51 |
| 1 frame, 90″ × 16″ | 1.27 |
| 1 frame, 88″ × 16″ | 1.25 |
| 1 frame, 60″ × 16″ | .85 |
| 2 frames, 94″ × 16″, at $1.33 each | 2.66 |
| 2 frames, 66″ × 16″, at 93 cents each | 1.86 |
| 1 frame, 24″ × 16″ | .34 |
| 1 frame, 84″ × 16″ | 1.19 |
| 1 frame, 20″ × 16″ | .33 |
| Total | $ 10.26 |

*Summary*

| | |
|---|---|
| Cellar | $ 9.76 |
| First story | 120.10 |
| Second story | 107.70 |
| Attic | 69.45 |
| Screens | 10.26 |
| Total cost of window sash | $317.27 |

### Cellar Stairs

*Quantities and Cost*

| | |
|---|---|
| 52 ft. of hemlock, at 3 cents per foot | $ 1.56 |
| 46 ft. of planed white pine, at 4½ cents per foot | 2.07 |
| Labor: 12 risers, at 20 cents each | 2.40 |
| Total | $ 6.03 |

### Back Stairs

*Quantities and Cost*

| | |
|---|---|
| 72 ft. 5/4 planed white pine, at 6 cents per foot | $ 4.32 |
| White-pine hand rails, 18 ft., at 6 cents per foot | 1.08 |
| Labor: 13 risers, at 40 cents each | 5.20 |
| Total | $ 10.60 |

### Main Stairs

*Quantities and Cost*

| | |
|---|---|
| 335 ft. of hemlock, at 3 cents per foot | $ 10.05 |
| 185 ft. of chestnut, at 10 cents per foot | 18.50 |
| 49 ft. of chestnut hand rail, at 60 cents per foot | 29.40 |

| | |
|---|---|
| 86 turned chestnut balusters, 2″ × 2″ × 10″, at 12 cents each | $ 10.32 |
| 1 box newel, 8″ × 8″ × 4′ 6″, chestnut, paneled, with molded cap | 6.00 |
| 7 newels, 5″ × 5″ × 4′ 6″, chestnut, with turned pendants, at $4 | 28.00 |
| 2 newels, 5″ × 5″ × 12′, chestnut, with turned caps, at $6 | 12.00 |
| Spandrel, 30 sq. ft., 10 raised panels, $\frac{7}{8}$-inch thick stiles and rails, $1\frac{1}{4}$-inch thick planted molding, at 35 cents per square foot | 10.50 |
| Paneled partition under stairs, chestnut, 17 sq. ft., at 35 cents per square foot | 5.95 |
| String molding, 46′ of $1\frac{1}{2}$″ × 3″, chestnut, at $3\frac{1}{2}$ cents | 1.61 |
| Skirt molding, 46′ of $1\frac{1}{2}$″ × $\frac{3}{4}$″, chestnut, $1\frac{1}{4}$ cents | .58 |
| Soffit molding, 38′ of $\frac{5}{8}$″ × 2″, chestnut, $1\frac{1}{2}$ cents | .57 |
| Labor: 35 risers, at $2 each | 70.00 |
| Total | $203.48 |

*Summary*

| | |
|---|---|
| Cellar stairs | $ 6.03 |
| Back stairs | 10.60 |
| Main stairs | 203.48 |
| Total cost of stairs | $220.11 |

### Miscellaneous Interior Joinery

*Baseboard*

| | |
|---|---|
| First story: | |
| Chestnut, $\frac{7}{8}$″ × 6″, with molding worked on face, tongued into surbase, $1\frac{1}{8}$″ × 6″, 139 ft., at 30 cents per linear foot | $ 41.70 |
| White pine, $\frac{7}{8}$″ × 9″, plain, 90 ft., at 33 cents | 29.70 |
| Second story: | |
| White pine, $\frac{7}{8}$″ × 9″, molded, 300 ft., at 33 cents per linear foot | 99.00 |
| Attic: | |
| White pine, $\frac{7}{8}$″ × 6″, molded, 290 ft., at 24 cents | 69.60 |
| Total | $240.00 |

*Wainscoting*

| | |
|---|---|
| First story: | |
| Chestnut, $\frac{7}{8}'' \times 2\frac{1}{2}''$, beaded and matched boards, 4 ft. high, 33 ft. long, 132 sq. ft., at 8 cents per square foot, dining room | $ 10.56 |
| Molded cap, $1\frac{1}{2}'' \times 1\frac{1}{2}''$, 33 ft., at 3 cents per foot | .99 |
| Chestnut, paneled, $67' \times 4'$ high = 268 sq. ft., at 35 cents per square foot | 93.80 |
| Molded cap, $1\frac{1}{4}'' \times 4''$, 67 ft., at 10 cents per foot | 6.70 |
| Second story (bathroom): | |
| White pine, $\frac{7}{8}'' \times 2\frac{1}{2}''$, matched boards, 4 ft. high, 128 sq. ft., at 8 cents per square foot | 10.24 |
| Molded cap, $1\frac{1}{2}'' \times 1\frac{1}{2}''$, 32 ft., at 3 cents per foot | .96 |
| Total | $123.25 |

*Picture Molding*

| | |
|---|---|
| Chestnut, $3'' \times 1\frac{1}{2}''$, 231 ft., at 9 cents | $ 20.79 |

*China Closet*

| | |
|---|---|
| Chestnut, dressed, 97 ft. B. M., at 10 cents per foot | $ 9.70 |
| Crown molding, $1'' \times 3''$, 8 ft., at 8 cents per foot | .64 |
| Labor: 1 man, 2 days, at $3.20 | 6.40 |
| Total | $ 16.74 |

*Shelving*

| | |
|---|---|
| No. 2 white pine, 50 ft. B. M., at $4\frac{1}{2}$ cents per foot | $ 2.25 |
| Labor: 1 man, 1 day, at $3.20 | 3.20 |
| Total | $ 5.45 |

*Summary*

| | |
|---|---|
| Baseboard | $240.00 |
| Wainscoting | 123.25 |
| Picture molding | 20.79 |
| China closet | 16.74 |
| Shelving | 5.45 |
| Total cost of miscellaneous interior joinery | $406.23 |

MISCELLANEOUS EXTERIOR WORK

*Moldings*

| | |
|---|---|
| 356 ft. crown molding, $1'' \times 4''$, at $5\frac{1}{2}$ cents | $ 19.58 |
| 356 ft. bed molding, $1'' \times 3''$, at 4 cents | 14.24 |

| | |
|---|---|
| 356 ft. bed molding, $1'' \times 1\frac{1}{2}''$, at 3 cents | $ 10.68 |
| 74 ft. bed molding, $1'' \times 2''$, at 3 cents | 2.22 |
| 356 ft. bed molding, $\frac{1}{2}'' \times \frac{7}{8}''$, at $1\frac{1}{2}$ cents | 5.34 |
| 64 ft. neck molding, at 1 cent | .64 |
| 36 ft. cove molding, $\frac{7}{8}'' \times 1\frac{1}{8}''$, at 3 cents | 1.08 |
| White pine: | |
| 35 ft. triglyphs, at 10 cents | 3.50 |
| 207 turned balusters, $2'' \times 1'\ 6''$, for porches, at 10 cents | 20.70 |
| 92 ft. molded hand rail, $5'' \times 3''$, at 11 cents | 10.12 |
| 92 ft. bottom rail, $5'' \times 3''$, at 11 cents | 10.12 |
| 200 dentils, $2'' \times 2'' \times 3''$, at $1\frac{1}{2}$ cents | 3.00 |
| 137 ft. window cap, $3'' \times 1\frac{1}{2}''$, at 3 cents | 4.11 |
| 23 ft. B. M., for balustrade posts, at $4\frac{1}{2}$ cents | 1.04 |
| Casing for circular window | 1.00 |
| Semicircular head-casing over outside door in dormer | 2.00 |
| Total cost of exterior work | $109.37 |

*Recapitulation of Cost of Joinery*

| | |
|---|---|
| Door frames | $158.67 |
| Doors | 224.93 |
| Window frames | 254.32 |
| Window sash | 317.27 |
| Stairs | 220.11 |
| Miscellaneous interior joinery | 406.23 |
| Miscellaneous exterior work | 109.37 |
| Total cost of joinery | $1,690.90 |

## HARDWARE

**9.** The prices given in the following list are based on the use of the best quality of hardware in the market. Should inferior quality be used, these prices would probably be 50 per cent. less. The cost of labor is assumed to be one-fifth the cost of the hardware.

### Locks

*Quantities and Cost*

| | |
|---|---|
| One $5\frac{3}{8}$-inch mortise front-door lock, with bronze furniture complete | $6.00 |
| One $4\frac{1}{2}$-inch mortise vestibule-door lock, with bronze furniture complete | 5.50 |
| One $5\frac{1}{2}$-inch flush pull mortise lock for double sliding door | 3.00 |
| Two $5\frac{1}{2}$-inch flush pull mortise locks for single sliding door, at $2.25 | 4.50 |
| Eighteen $4\frac{1}{2}$-inch mortise knob locks, at $2.20 | 39.60 |
| Ten 4-inch cupboard lock sets, at $1.85 | 18.50 |
| Six $2\frac{3}{8}$-inch mortise knob locks, at $1.50 | 9.00 |
| One 2-inch steel spring padlock | .50 |
| Total | $86.60 |

### Hinges

*Quantities and Cost*

| | |
|---|---|
| 1 pair double-acting checking spring hinges with bronze push plates, for double-acting door | $10.50 |
| 2 pair $5'' \times 5''$ bronze loose pin butts, at $2.50 | 5.00 |
| 33 pair $4'' \times 4''$ bronze loose pin butts, at $1.90 | 62.70 |
| 2 pair $3'' \times 3''$ bronze loose pin butts, at $1.35 | 2.70 |
| Total | $80.90 |

### Miscellaneous Hardware

*Quantities and Cost*

| | |
|---|---|
| Thirty-two $1\frac{1}{8}'' \times 2\frac{5}{8}''$ bronze sash fasts, at 40 cents | $12.80 |
| Five $2'' \times 2\frac{1}{4}''$ bronze cupboard turns, at 40 cents | 2.00 |
| Four $6'' \times 1\frac{1}{4}''$ bronze flush bolts, at $1.25 | 5.00 |
| 3 doz. 3-inch japanned-iron coat hooks, at 25 cents | .75 |
| One galvanized-iron hasp and staple | .20 |
| One McCabe patent door hanger, double | 3.50 |
| Two McCabe patent door hangers, single, at $2 | 4.00 |
| Four $2\frac{1}{4}$-inch bronze draw pulls, at 10 cents | .40 |
| Total | $28.65 |

*Summary*

| | |
|---|---|
| Locks | $86.60 |
| Butts | 80.90 |
| Miscellaneous | 28.65 |
| Total cost of hardware | $196.15 |

## HEATING AND VENTILATING SYSTEM

**10.** A house as large as the one under consideration should be heated either by steam or by hot water. However, a furnace is used in this case, not because it is the best practice, but because it gives practice in estimating on a furnace, which is more important than estimating on either steam or hot water. In taking off quantities for the heating and ventilating contract, attention should be given to the fact that the furnace and pipes, registers and borders, and the fireplace furniture are usually supplied by different manufacturers.

### Furnace

*Quantities and Cost*

| | |
|---|---|
| One 53-inch cast-iron portable furnace set up in place | $125.00 |

### Warm-Air and Smoke Pipes

*Quantities and Cost*

| | |
|---|---|
| 12 ft. of 4″ × 8″ tin W. A. pipe, at 12½ cents | $ 1.50 |
| 12 ft. of 3″ × 12″ tin W. A. pipe, at 15 cents | 1.80 |
| 13 ft. of 4″ × 10″ tin W. A. pipe, at 15 cents | 1.95 |
| 61 ft. of 10-inch round tin W. A. pipe, at 16 cents | 9.76 |
| 12½ ft. of 8-inch round tin W. A. pipe, at 12½ cents | 1.56 |
| 4 ft. of 8-inch galvanized-iron smoke pipe, at 15 cents | .60 |
| 17 ft. of 10-inch round, fireclay flue lining, at 25 cents | 4.25 |
| 2½ ft. of 8-inch round, fireclay flue lining, at 20 cents | .50 |
| Labor, one-half of cost of materials | 10.96 |
| Total | $ 32.88 |

### Registers

*Quantities and Cost*

| | |
|---|---|
| Three 14″ × 16″ japanned floor registers and borders, at $3.85 | $ 11.55 |
| One 7″ × 10″ japanned floor register and border | .85 |
| One 12″ × 15″ japanned floor register and border | 2.25 |
| Two 7″ × 9″ japanned floor registers and borders, at 85 cents | 1.70 |
| One 10″ × 12″ japanned floor register and border | 1.26 |
| Two 12″ × 15″ japanned wall registers and borders, at $2.25 | 4.50 |
| One 10″ × 12″ japanned wall register and border | 1.26 |
| Labor, one-third of cost of materials | 7.79 |
| Total | $ 31.16 |

### Tin Register Boxes

*Quantities and Cost*

| | |
|---|---|
| Three 14″ × 16″ × 4″, at 80 cents | $ 2.40 |
| One 7″ × 10″ × 4″ | .57 |
| Two 10″ × 12″ × 4″, at 75 cents | 1.50 |
| Two 15″ × 12″ × 4″, at 75 cents | 1.50 |
| Two 7″ × 9″ × 4″, at 57 cents | 1.14 |
| Labor, one-third of cost of materials | 2.37 |
| Total | $ 9.48 |

### Miscellaneous

*Quantities and Cost*

| | |
|---|---|
| Fifteen elbows, 10 in. in diameter, at 35 cents | $ 5.25 |
| Two elbows, 8 in. in diameter, at 25 cents | .50 |
| Ten sheets of "IC" tin, 20″ × 28″, at 20 cents | 2.00 |
| Two cold-air boxes, each 24 ft. long, of 20-inch earthen pipe, with two slide dampers and screens | 38.40 |
| Labor: one-third of cost of materials | 15.38 |
| Total | $61.53 |

*Summary*

| | |
|---|---|
| Furnace | $125.00 |
| Warm-air and smoke pipes | 32.88 |
| Registers and borders | 31.16 |
| Register boxes | 9.48 |
| Miscellaneous | 61.53 |
| Total cost of heating and ventilating system | $260.05 |

## PLUMBING

**11.** A complete list of the plumbing fixtures, together with the sizes, lengths, and materials of all pipes, should be tabulated so that any item can be easily referred to in case of alteration in the schedule.

### Fixtures

*Quantities and Cost*

| | |
|---|---|
| One double-oven brick-set kitchen range with water-back; to be selected by the owner; complete | $ 50.00 |
| One Class A, white-glazed earthenware sink, 30″ × 20″ × 7″; with porcelain back 15 in. high, and with porcelain legs; 2-inch cast brass, nickel-plated; **S** trap with waste pipe to floor; and improved Fuller faucets; telescopic ash drain board; complete | 45.00 |
| One Class A, 20″ × 30″ porcelain recess pantry sink, white enameled inside, with nickel-plated standing waste overflow; with nickel-plated $1\frac{1}{2}$-inch brass trap and pipe to floor; nickel-plated supply pipes to floor; nickel-plated 2-inch supporting stand, and heavy nickel-plated Fuller faucets, marked *hot* and *cold;* complete | 40.00 |
| One 5′ 6″ porcelain-lined, roll rim, Roman pattern, cast-iron bath, with cast-iron feet, painted one coat outside, with nickel-plated combination standing waste, compression star handle supply valves at foot, with *hot* and *cold* name plates; complete | 40.00 |

| | |
|---|---|
| One improved porcelain siphon-jet water closet, with quartered-oak seat and cover, quartered-oak siphon cistern, with nickel-plated brass brackets, nickel-plated brass flush pipe; nickel-plated chain and china pull, and brass floor flange; complete . | $ 30.00 |
| One enameled-iron corner, lavatory, $17\frac{1}{2}'' \times 17\frac{1}{2}'' \times 12''$, with $12'' \times 15''$ **D**-shaped basin with nickel-plate cocks and pipes; all complete . . . . . | 30.00 |
| One enameled-iron corner lavatory slab $16'' \times 16'' \times 6''$, with enameled back and aprons, soap cup, $11'' \times 14''$ bowl, No. 0 Fuller faucets, and "Penn" waste; complete . . . . . | 20.00 |
| One set of 3 Class B, white porcelain wash tubs, 26 inches long, with N. P. brass waste and star handle cocks, and wringer base; all complete . . | 60.00 |
| Cost of fixtures . . . . . | $315.00 |

### Water Supply

*Quantities and Cost*

| | |
|---|---|
| One 40-gallon, extra-heavy, galvanized-iron boiler, stand and couplings; complete . . . . . | $15.00 |
| Tapping and corporation-cock permits . . . . . | 5.00 |
| One curb box . . . . . | 2.00 |
| 10 ft. 1-inch brass pipe and fittings . . . . . | 5.00 |
| 40 ft. 1-inch AAA lead pipe . . . . . | 19.00 |
| 44 ft. 1-inch galvanized-iron pipe . . . . . | 4.00 |
| 120 ft. $\frac{3}{4}$-inch galvanized-iron pipe . . . . . | 9.00 |
| 80 ft. $\frac{1}{2}$-inch galvanized-iron pipe . . . . . | 5.00 |
| 30 pounds of fittings . . . . . | 6.00 |
| One 1-inch stop and waste cock . . . . . | 1.50 |
| Eight $\frac{3}{4}$-inch stop and waste cocks . . . . . | 7.00 |
| Three $\frac{1}{2}$-inch stop and waste cocks . . . . . | 2.50 |
| Straps and hangers . . . . . | 1.00 |
| Two garden hose bibbs . . . . . | 2.00 |
| Cost of water-supply system . . . . . | $84.00 |

DRAINAGE

*Quantities and Cost*

| | |
|---|---|
| 213 ft. 4-inch, extra-heavy, cast-iron, asphalt-coated soil pipe | $ 60.00 |
| 20 ft. 3-inch, extra-heavy, cast-iron, asphalt-coated soil pipe | 4.50 |
| 110 ft. 2-inch, extra-heavy, cast-iron, asphalt-coated soil pipe | 16.50 |
| 30 ft. 4-inch, extra-heavy, cast-iron, asphalt-coated, soil-pipe fittings | 24.00 |
| 4 ft. 3-inch, extra-heavy, cast-iron, asphalt-coated, soil-pipe fittings | 2.50 |
| 24 ft. 2-inch, extra-heavy, cast-iron, asphalt-coated, soil-pipe fittings | 7.50 |
| 90 ft. 6-inch, salt-glazed, earthenware sewer pipe | 10.00 |
| 62 ft. 5-inch, salt-glazed, earthenware sewer pipe | 6.00 |
| 140 ft. 4-inch, salt-glazed, earthenware sewer pipe | 8.00 |
| One 6-inch fitting | 1.00 |
| Seven 5-inch fittings | 4.00 |
| Eighteen 4-inch fittings | 7.00 |
| Portland cement | 2.00 |
| 100 lb. of lead | 5.00 |
| Oakum | 1.00 |
| Wall hooks | 1.00 |
| One 4-inch running trap | 2.00 |
| Four 4-inch ground brass ferrule cleanouts | 2.00 |
| Three cast-iron manhole covers | 3.00 |
| One fresh-air inlet box | 1.00 |
| One 4-inch lead bend | 1.50 |
| One 4-inch brass ferrule | .35 |
| 10 ft. 2-inch lead waste pipe | 2.50 |
| 14 ft. $1\frac{1}{2}$-inch lead pipe | 2.50 |
| Twelve 2-inch brass ferrules | 1.50 |
| Two 2-inch lead traps | 2.50 |
| 2 sq. ft. 6-pound sheet lead | .90 |
| Three 4-inch wire-basket strainers | .40 |
| 20 lb. of wiping solder | 5.00 |
| Total | $185.15 |

LABOR

| | |
|---|---|
| Labor, assumed to be one-fourth cost of all materials = $584.15 × 25 = | $146.04 |

*Summary*

| | |
|---|---|
| Fixtures | $315.00 |
| Water-supply system | 84.00 |
| Drainage | 185.15 |
| Labor | 146.04 |
| Total cost of plumbing | $730.19 |

## GAS-FITTING

**12.** Following is given the cost of buying and installing the various gas fixtures and pipes that are used in the building under consideration:

FIXTURES

*Quantities and Cost*

| | |
|---|---|
| Cellar: | |
| 2 brackets, 1 burner, each at 50 cents | $ 1.00 |
| First floor: | |
| Parlor, 1 chandelier, 4 burners | 50.00 |
| 2 brackets, stiff, 2 burners, each at $10 | 20.00 |
| Dining room, 1 chandelier, 5 burners | 45.00 |
| 2 brackets, stiff, 1 burner, each at $5 | 10.00 |
| Hall, 1 chandelier, 4 burners | 30.00 |
| Library, 1 chandelier, 6 burners | 50.00 |
| 2 brackets, stiff, 2 burners, each at $10 | 20.00 |
| Lavatory, 1 bracket, 1 burner, stiff | 2.50 |
| Kitchen, 1 center fixture, 2 burners | 4.00 |
| 1 side light, stiff, 1 burner | 1.00 |
| Butler's pantry, 1 drop light, 2 burners | 4.00 |
| Pantry, 1 side light, stiff, 1 burner | 1.00 |
| Cellar stairs, 1-bracket light, 1 burner | .50 |
| Second floor: | |
| Bedrooms, 11 double-swing brackets, 1 burner, at $5 | 55.00 |
| Dressing room, 1 double-swing, plain, 1 burner | 2.00 |

| | |
|---|---|
| Hall, 1 stiff bracket, 2 burners | $ 6.00 |
| Stair landing, 2 stiff brackets, 1 burner, each at $4 | 8.00 |
| Bathroom, 1 bracket, double swing, plain, 1 burner | 3.00 |
| Attic rooms, 5 stiff brackets, 1 burner, each at $.75 | 3.75 |
| Total | $316.75 |

PIPE AND FITTINGS

*Quantities and Cost*

| | |
|---|---|
| 54 ft. $1\frac{1}{2}$-inch pipe, at 10 cents | $ 5.40 |
| 30 ft. $\frac{3}{4}$-inch pipe, at 6 cents | 1.80 |
| 30 ft. $\frac{1}{2}$-inch pipe, at 4 cents | 1.20 |
| 205 ft. $\frac{3}{8}$-inch pipe, at 3 cents | 6.15 |
| Fittings | 4.00 |
| Total | $ 18.55 |

LABOR

| | |
|---|---|
| Labor, assumed to be one-seventh the cost of materials (fixtures, pipes, etc.) = $335.30 ÷ 7 = | $ 47.90 |

*Summary*

| | |
|---|---|
| Fixtures | $316.75 |
| Pipe and fittings | 18.55 |
| Labor | 47.90 |
| Total cost of gas-fitting | $383.20 |

## WIRING

**13.** At the present time, most houses that are as large as the one under consideration are equipped with electric door bells, and probably with electric bells from some of the living rooms to the kitchen. Such an equipment would cost, say, $25.

In most houses of this size, where available, both electricity and gas are used for lighting purposes. The cost of wiring this house complete for electric lights, including six wall switches, besides two three-way switches for the hall light, so that it can be operated either from the upper or lower floor, is about $325 if iron-armored conduit is used.

If electric lights are used, the lighting fixtures must be combination fixtures, that is, fixtures that can be used for both gas and electricity. This will add about 40 per cent. to the cost of the gas fixtures, or 40 per cent. of $316.75, which amounts to $126.70.

The total cost of wiring is therefore as follows:

| | |
|---|---|
| Electric bells | $ 25.00 |
| Light wiring | 325.00 |
| Extra cost of fixtures | 126.70 |
| Total | $476.70 |

## PAINTING

**14.** In taking off quantities for painting, it is customary to estimate the cost by assuming a price per square yard for each class of work, instead of estimating the material and labor separately.

### Exterior Work

*Quantities*

Three coats of pure linseed oil and white lead in four colors:

| | Square Yards |
|---|---|
| Shingles (see item in Carpentry estimate) | 269 |
| Main cornice | 130 |
| Porch cornice | 22 |
| Porch posts | 32 |
| Spandrels | 40 |
| Porch skirting | 14 |
| Balustrade | 52 |
| Sash | 64 |
| Window sills | 16 |
| Porch floors and steps | 72 |
| Total | 711 |

| One coat orange shellac and one of varnish: | Square Yards |
|---|---|
| Porch ceiling (see item in Carpentry estimate) | 58 |

INTERIOR WORK

*Quantities*

Chestnut finish, parlor, library, dining room, hall, stair hall, lavatory, and stairway. One coat of wood paste filler, one coat of white shellac, and three coats of varnish, rubbed down with pumice stone and water:

| | SQUARE YARDS |
|---|---|
| Architrave | 32 |
| Base | 16 |
| Wainscoting | 30 |
| Sash | 17 |
| Doors | 54 |
| Jamb casings | 7 |
| Stairway | 50 |
| Balustrade of stairway | 20 |
| Total | 226 |

White pine, natural finish, all of house not finished in chestnut. One coat of spirit shellac and two coats of varnish:

| | SQUARE YARDS |
|---|---|
| Architrave | 73 |
| Base | 60 |
| Wainscoting | 29 |
| Sash | 40 |
| Dresser | 9 |
| Doors | 131 |
| Jamb casings | 31 |
| Back stairs | 34 |
| Total | 407 |

*Cost*

| | |
|---|---|
| Exterior work, 711 sq. yd., at 30 cents per square yard | $213.30 |
| Porch ceiling, 58 sq. yd., at 20 cents per square yard | 11.60 |
| Chestnut finish, 226 sq. yd., at 75 cents per square yard | 169.50 |

| | |
|---|---|
| White pine, natural finish, 407 sq. yd., at 25 cents per square yard | 101.75 |
| Total cost of painting | $496.15 |

## SUMMARY OF COST OF BUILDING

**15.** Having estimated the cost of work required of each trade, a summary of the whole will express the total estimated cost of the building.

| | |
|---|---|
| Excavation and filling | $ 285.99 |
| Stonework | 1,793.83 |
| Brickwork | 1,079.16 |
| Carpentry | 2,001.57 |
| Roofing | 553.18 |
| Plastering | 1,025.18 |
| Joinery | 1,690.90 |
| Hardware | 196.15 |
| Heating and ventilation | 260.05 |
| Plumbing | 730.19 |
| Gas-fitting | 383.20 |
| Electric wiring | 476.70 |
| Painting | 496.15 |
| Total cost | $10,972.25 |

This total cost does not include any extras or builder's profits.

# CONTRACTS

## BUILDING CONTRACTS

### INTRODUCTION

**1. Scope of Subject.**—The parties to a building contract are usually the builder, the owner, and the architect, although in some cases the architect is not a party. Building contracts are nearly always between the owner and the builder, with the architect as advisor and arbitrator. In this Section, contracts will be explained and discussed in such a manner that a practical knowledge of the business relations that exist between the several parties to a building operation will be acquired, and the relative positions of these parties in the eyes of the law will be comprehended.

### CHARACTER OF THE AGREEMENT

#### NATURE OF A CONTRACT

**2. Definition.**—A **contract** is a formal agreement between two parties for doing or not doing some definite thing. It is very clearly defined by Woolsey ("Introduction to International Law") as, "One of the highest acts of human free will, binding itself in regard to the future, and surrendering the right to change a certain expressed intention, so that it becomes morally and jurally a wrong to act otherwise; it is the act of two parties, in which each, or one of the two, conveys power over himself to the other, in the consideration of something done or to be done by the other."

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In the strictest sense, a contract is an agreement enforcible by law—an agreement based on sufficient consideration, and in such a form, and made under such circumstances, that a breach of it is good cause for action by law. It is this sense of validity before the law that distinguishes a contract from a simple agreement, the parties to which are not bound in such a formal way and are not amenable to one another for its fulfilment.

**3. Parties to a Contract.**—In the execution of every building operation of any size and importance, there are at least three persons interested—the *owner*, the *builder*, or *contractor*, and the *architect*. The owner is the person vitally interested, because it is his money that is being expended, and it is natural that he should want to receive the best material and workmanship consistent with the size and quality of the building to be erected and the amount of money to be expended. The builder, who is party to the contract, agrees to accomplish certain results for a stipulated amount of money, and in deciding the extent of his responsibility toward the owner, may be tempted to interpret the contract to best suit his own interests. The architect is employed by the owner as an expert adviser in matters of building, and is the judge that decides for the owner whether the builder is doing his duty and fulfilling his contract.

Though all men are deemed honest unless proved otherwise, it may readily be seen that a dishonest builder might, unless some valid agreement existed, make considerable trouble for the owner. The builder is even more at the mercy of a dishonest owner, for he might be led into a building operation that would require the expenditure of considerable time and money, and then, after the work is completed, he would be unable to collect the amount of his bill. This would more than likely put him to the additional expense of long and wearisome litigation, which, though the courts sustained his claim, might cause bankruptcy before he could recover it.

Even though each of the parties should be perfectly honest and inclined to deal fairly with each other, it is necessary to

have a contract that will stipulate the terms of the agreement in a perfectly clear and concise manner—drawn up, agreed to, and signed by each party concerned—so that each, over his own signature, will have defined for him his responsibilities and duties in the transaction.

**4. Classes of Contracts.**—Contracts may be divided into three classes: *written, oral* (or, as it is sometimes called, *parol*, or *verbal*), and *implied contracts.*

A **written contract** is one wherein the terms of the agreement are written or printed, and signed by the contracting parties.

An **oral,** or **verbal, contract** is one in which the parties concerned agree verbally (usually in the presence of witnesses) to transact or perform certain things.

An **implied contract** is one that is *understood* to exist, through the very nature of things, between two parties without any previous written or verbal agreement. For instance, one person employs another to perform a certain piece of work and thereby implies an obligation for reasonable remuneration to the person that performs the work; or a person accepts the benefits accruing from the performance of such work, and thereby implies an obligation to have satisfactorily performed the labor for which he was paid.

Most contracts embody at least two of the foregoing conditions, for the reason that it is almost impossible to fully cover all the terms of an agreement in a written or an oral contract, and much must be implied if a successful performance of the work is understood.

**5. Written Contracts.**—A written contract is usually regarded, though incorrectly, as more binding than either of the others. Its preference over the other forms lies in the fact that the statements of the agreement are in black and white, and, being signed by the parties concerned, cannot well be refuted; and since a certain amount of formality is required in order to draw up a written contract, the law regards the document as the finished and definite conclusion of all the preceding negotiations of the contracting parties and

as fully expressing the understanding between them in regard to the terms of the agreement.

That verbal agreements are regarded in such an unfavorable light by the law is probably due to the fact that witnesses and parties to a verbal agreement, as a rule, when called on in court to testify, utterly fail to agree in their statements as to what really was said on the specified occasion. The court is, therefore, inclined to accept and hold paramount any document that will explain, in any degree, the real understanding between the contracting parties. Hence it is, that even a note in the memorandum book of one of the parties concerned, or in a book of a third and disinterested party, as to the terms of the agreement, will be looked on with favor by the court, and will usually be held, should it prove to be genuine memoranda, as testimony of importance above that of a witness to the verbal transaction.

**6. Oral Contracts.**—It must not be thought that, in the absence of written documents, verbal contracts or agreements can be broken with impunity by either party, for such is not the case, as it is the custom of the courts in matters of this kind to endeavor to ascertain through witnesses and from circumstances the real understanding existing between the parties to such a contract, and to deal fairly with them, commensurate with the testimony and evidence given.

**7. Implied Contracts.**—Where the owner of a building stands by and sees certain improvements made, or labor performed, from which he will derive benefit, he implies a contract for the work, and is in duty bound to pay a commensurate price for the same, unless there is some stipulation to the contrary in a definite contract, or where there is some written document, previously made, that in some way nullifies this implied contract. For instance, the written contract may set forth that "No payments shall be made for extra work done by the contractor unless authorized, in writing, by the owner," or "by the architect." In this case, if the contractor does any extra work for which he has no written

order, he does it at his own risk, and would have no action against the owner in court.

In order to make clear the extent of an implied contract, the following illustration is of interest: A plumber was subcontractor to a builder during the erection of a house; the builder was subsequently discharged by the owner for drunkenness, but the plumber went on with his work, under the observation, and in some instances under the direct orders, of the owner. Having finished his work, the plumber looked to the owner for payment, which was refused on the ground that the builder had already been paid for the work. The plumber brought suit for the amount due him, and, though it was proved in court that the builder had been paid enough on the building to cover the plumber's claim, the court recommended that, if the evidence warranted it, the jury should oblige the owner to pay the plumber for at least such work as he had done subsequent to the builder's discharge. This view of the case was taken by the court on the ground that "Where one stands in silence and sees work done, or materials furnished for work done upon premises belonging to him, of which he accepts the benefit, a promise to pay the value thereof may properly be inferred."

**8. Competitions: Contract by Tender.**—Where designs or plans are submitted in compliance with the terms of a circular or printed notice, setting forth an invitation for such designs or plans and offering some inducement for same, it is regarded and has been declared by the courts to be a contract. In order that the validity of such a proposal be made certain, its terms should be set forth clearly and distinctly, and the person accepting the terms should comply with them strictly and to the letter. Proposals of this kind are advertised by committees or individuals, who call for competitive drawings of some public or private building. The submission of plans or designs in strict compliance with the terms of the advertisement constitutes a contract that is upheld by law, provided the advertisement is issued by persons of proper authority and responsibility.

Should a committee call for architectural designs that are to comply with certain conditions or requirements, and by subsequent notice modify these conditions to such an extent as to make worthless certain plans partially prepared by one of the competing architects, said architect would be able to recover the cost of such preparation. But if he had not commenced the designs until after the modified circular of advertisement had been issued, the later program would take precedence over the first and be held as embodying the terms of the contract.

Should the committee set forth conditions that would be impossible for an architect to fulfil in the design of any one building (such as a demand for certain accommodations that could not be provided for the stipulated sum of money), the architect should get the vote of the committee as to which requirement—cost or accommodation—takes precedence and which he is to disregard. The opinion of any one member of the committee is not sufficient, and only the joint decision of the entire committee should be accepted. Therefore, in issuing circular invitations for proposals or competitive drawings, great care should be taken to state in clear terms just what is wanted and required, and equal care should be exercised by any one complying with the terms, for not only has the law but little relief for persons that do not know how to express their ideas, but it also extends little hope to those that cannot understand a clear statement and misconstrue the intent of the published requirements.

### THE CONTRACTING PARTIES

**9. Formal Contracts.**—A **formal contract** consists of a direct and pertinent proposal from the one party and an unconditional acceptance by the other. Such a contract may be made by a letter proposing certain terms, and duly accepted by a letter in reply, or the more usual form of a written agreement, setting forth in full the requirements of the one party and the unconditional acceptance of them by the other, and signed by both parties. In all formal contracts, the terms must embody every condition that is to be

complied with, and should be so explicitly stated as to be clearly understood by the contracting parties, so that there may be no misunderstanding between them in regard to the performance of the one party and the demands of, and consideration to be paid by, the other.

**10. Contracting With Corporations.**—An agreement entered into with a corporation differs very materially from one contracted with an individual. Almost any contract (provided it is not immoral) is binding on an individual, provided the intention is well defined and understood and a consideration is to be made for its fulfilment. Such, however, is not the case with a corporation. It behooves the person about to make a contract with a corporation to inquire into the scope of its charter, and to ascertain the limit of its powers to make such contract and the authority of its officers who are to negotiate the contract. In England, a contract requires the seal of the corporation in addition to the signatures of the proper officials in order to insure its validity, and such was formerly the case in the United States, though in many of the states the signatures of the proper officers are generally considered sufficient, provided they have the required authority through their charters and by-laws. In fact, courts in so many of the states have taken this view that it is more than likely, should similar cases arise in the other states, the courts would hold the same opinion. Irrespective of the matter of the seal, however, it is of vital importance in making a contract with a corporation to ascertain whether the persons representing the corporation are invested with the proper authority to make such a contract and that the corporation is bound to recognize it. There is no redress, and no action will be sustained, if the person entering into a contract with a corporation has, through his own neglect to obtain such information, entered into a contract with officials lacking the proper authority, and at variance with the charters and by-laws of the corporation.

**11. Public Contracts.**—In entering into a contract with a public body, even when the officials representing such

a body are duly authorized, it is imperative to make the contract with due formality, or it will not be legal. For instance, it has been held in several states that the county was not bound by a contract entered into by the county commissioners unless the commissioners were convened in a regular meeting of the board. A contract entered into informally, even within the legal authority of the officials, is insufficient.

When a contract is made with a public corporation for work to be performed under the supervision of a committee, such as a town committee, the contractor should ascertain whether the contract is made through the concurrence of a majority of the committee. Not only does this apply to an original contract, but also to any alterations to be made in one already entered into.

The contractor, in other ways, runs many more risks in dealing with corporations than he does with individuals, for a mechanic's lien is without effect against any public building, such as a schoolhouse, jail, court house, or town hall; and even aside from state, county, and town corporations, no such lien can be maintained against the property of a corporation operating for the accommodation of the public, such as railroad stations, ferry houses, etc.

Again, a public corporation is sometimes exempt from fulfilling its contract. An instance of this occurred in New York, when a contract was made for a public building. The erection, however, was postponed, and the contractors brought suit to force the fulfilment of the contract, but, though the contract was drawn with due formality and was perfectly legal, the court of appeals decided that a state could not be compelled by a contractor to erect a building, and that his only redress, provided the state broke the agreement and he himself was not in default, was a claim for damages, which must be made in the form of a petition to the state legislature.

**12. False Representation.**—Through lack of caution on his part, a contractor frequently finds that he has made

an agreement with persons that, though they have represented themselves as authorized to execute the contract, have no such legal authority. The corporation, therefore, refuses to pay the contractor his consideration, and he has no action against that body, though he may possibly recover damages from the persons that caused him to enter into the contract under false representations. It is, therefore, a good plan and a safeguard to both parties to have this matter clearly defined before the agreement is signed. It is, in fact, sometimes a matter of doubt whether the members of a committee who sign their names to a contract for building, to be paid for by a public corporation, do not sometimes, through the wording of the agreement or the manner of signing it, make themselves each personally liable for the amount of the contract.

**13. The Lowest Bidder.**—It is the common supposition that the award of a contract must be made to the lowest bidder, unless there is a statement in the tender for bids that stipulates that the parties making the tender "reserve the right to reject any or all bids." This is not the case, however, as no such stipulation is required, and the parties making the tender can omit such a clause without being bound to prefer the lowest bidder. The laws of some states and many public and private corporations require that bids shall be asked for all work involving an expenditure above a certain amount, and the proposal of the lowest bidder accepted. This being the case, the officials making the contract are bound to award it to the lowest bidder. When the stipulation is made in the tender calling for bids on certain work, that "the contract shall be awarded to the lowest responsible bidder," the discretion allowed the parties making the tender is so great in regard to what they may consider as constituting the "responsibility" of the bidder, that the law virtually admits that they may award the contract to whomsoever they may see fit, so long as they have decided truly in their own minds which party is the lowest *responsible* bidder.

The extent to which parties may be held in awarding a contract by the statement in the tender, that the award shall be made to the "lowest bidder," is well set forth in the confirmation of a decision by the Supreme Court of Pennsylvania. A case arose in Pittsburg, where the water committee awarded a contract for some mains to a party that was $5,000 higher than the lowest bidder. The lowest bidders having complied with all the terms of the tender and furnished the proper bond, felt that they were entitled to the contract, and applied for a mandamus in order to compel the committee to award the contract to them. The committee, in reply to the court's inquiry to ascertain if the mandamus should be granted, stated "that it was within their full knowledge and belief, that on a previous occasion the said firm had by some means or other attempted and did perpetrate a gross deceit and wrong on them, in surreptitiously departing from the specifications for a certain contract for the construction of boilers for the new waterworks, by striking therefrom, without the knowledge or consent of the said committee, the word *mud-drum;* also, that it was within the knowledge of some, if not all, of the members of the water committee, that the senior member of the firm was a man of intemperate habits, whose character for sobriety was not such as would warrant the committee in giving said firm a responsible contract; that the senior member also had attempted to bribe the mechanical engineer of the waterworks, who was the inspecting officer of said contract." They further stated that the firm was otherwise disqualified for the proper fulfilment of the requirements of the proposed contract. The report of the commissioner appointed in the case to take testimony showed that the said firm was the lowest bidder, and from a pecuniary standpoint was responsible; and while, in the opinion of the commissioner, the committee fully believed that the statements made were true, it was found that inquiry on the part of the committee would have shown that none of the three accusations made, as to attempted deceit, intemperance on the part of the senior member, and bribery of the engineer, was substantiated. Notwithstanding

this, the court held that the committee's action could not be changed.

The Supreme Court, in the confirmation of the lower court's decision, said: "The learned judge who, as the mouthpiece of the court to which this case was submitted, delivers the opinion, finds that the facts stated in the petition are true, and that the allegations contained in the answer, as above set forth, are wholly without foundation, but that, notwithstanding this, the committee fully believed that what was asserted in the answer was true. We must take this opinion of the court as to the belief of the respondents to be correct; nevertheless, it does somewhat surprise us, that this body of men, intrusted with so important a duty, should have rested so contentedly under a delusion which a little inquiry in the right direction would have dissipated, and thus save a handsome sum of money to the city treasury." In regard to the word *responsible* the court held that it means something more than pecuniary ability, and further stating the case said, "In a contract such as the one in controversy, the work must be promptly, faithfully, and well done; it must, or ought to be, conscientious work; to do such work requires prompt, skilful, and conscientious men. A dishonest contractor may impose work upon the city in spite of the utmost caution of the superintending engineer, apparently good, and even capable of bearing its duty for a time, which in the end may prove to be a total failure, and worse than useless. Granted that from such a contractor pecuniary damages may be recovered by an action at law, this at best is but a last resort, that often produces more vexation than profit—a mere patch upon a bad job—an exceedingly meager compensation, at best, for the delay and incalculable damage resulting from the want of a competent supply of water. The city requires honest work, not lawsuits. Were we to accept the interpretation insisted upon by the relators, the difference of a single dollar, in a bid for the most important contract, might determine the question in favor of some unskilful rogue, as against an upright and skilful mechanic. Again we know that, as a

rule, cheap work and cheap workmen are but convertible terms for poor work and poor workmen, and if the city, for the mere sake of cheapness, must put up with this, it is indeed a most unfortunate position. It is settled beyond controversy, that where the complaint is against a person or body that has a discretionary or deliberate function to exercise, and that person or body has exercised that function, according to the best of his or its judgment, the writ of mandamus will not be granted to compel the undoing of what has been done."

Bidders for public work under the statute that work shall be given to the lowest bidder, must comply strictly with the terms of the tender if they expect their proposal to be accepted or even considered as the lowest bid.

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### THE SIGNATURE

**14. What a Signature Implies.**—Since a contract is a mutual agreement between two or more parties, it becomes essential to its legality that there should be available proof of the fact that the contracting parties thoroughly understand it in the same way and willingly assent to the obligations incurred by the conditions—in other words, that the parties are of one mind. Therefore, when the signatures of all the contracting parties are affixed to the document setting forth the terms of the contract, they are deemed by law as evidence of this mutual agreement and understanding, and impart validity to the document.

A signature may be the inscribed name by which a party is known; or in case he cannot write, his mark, or cross, will be regarded as legal, provided it is witnessed and his name is written near it in the customary way and by a duly authorized party. It has been held, however, that a signature "by mark" is *not* valid if made by the other party to the contract for the one signing the contract by mark.

There are cases where it is not necessary that a person should sign a contract in order to be bound by its conditions. For instance, a person is mentioned in a contract as one of

the signers, and he is also to act as an attorney for another party to the same contract. If he signs only as attorney for the other person and does not sign on his own account, he is nevertheless a party to its fulfilment, the same as though he had signed it in his own name. It has been held in court, that since he must have read the document before signing it as attorney, and must have seen that he was personally mentioned as one of the signers, by failing to make any remonstrance against it and by accepting its benefits, he assented to its terms and became a party to its fulfilment, the same as though he had signed it in his own name. It is reasonable, therefore, to suppose that any person knowing the terms of a contract and being aware that he is personally interested in it who stands by without resistance or remonstrance and sees it drawn up and afterwards accepts the benefits recurring from such agreement, will be held responsible by law and will have no excuse on the ground that his actual signature is not on it.

If the signature of a person appears on a contract as a party to that contract, the law assumes that the signer is able to read and is familiar with the contents of the document. It is not necessary in the first instance to prove that the contract was willingly signed, that an opportunity was afforded to read the document, and that no means were used to prevent the signer from reading it. Such proof is necessary only if there is allegation to the contrary.

If a party to a contract is unable to read or write, and his signature to the document is made by mark, there must be a subscribing witness, and then the law assumes that the contents of the contract were made known to him, and will not excuse him from its obligations unless he can prove that its contents were not read or explained to him or that he signed under compulsion.

Where the contract is in a language not understood by him, the signer occupies the same position with regard to the law, as just stated, where he cannot read or write. If the question arises, it must be proved that the contract was translated to the signer with sufficient clearness to give him a fair

understanding of its terms, and that no deception was practiced or misrepresentations made.

Therefore, before signing, the party about to affix his signature should read the contract over carefully, in all its parts; not only should he read any printed matters that may be embodied in it, but he should consider carefully any script that may be interlined between the printed substances, as writing is held by the courts to take preference over printed statements, and where there is any inconsistency existing between the two, the written portion controls, as more attention is usually paid by the contracting parties to the written matter. No party, however, is excusable on the plea that he did not read the printed form. Such a case was tried in the District of Columbia. The party, on having the written part of an agreement read to him, ordered his signature to be placed on the instrument, without reading or having read to him the printed substance of the agreement. As it was proved that he could read, and had an opportunity to do so, it was held by the court that he was responsible for the agreement in the terms and to the purport of the entire document.

**15. Unsigned Agreements.**—A contract signed by one party and then delivered to the other is binding on the one who signs the agreement, whether the other party signs it or not. Such a case was decided in the Supreme Court of New York. A party receiving an unsigned agreement by messenger affixed his signature, and on handing it to the messenger remarked that he would not be bound by it unless certain things were done. He afterwards wrote to the other party to the agreement that he refused to be bound by it, and withdrew. The court held, notwithstanding the fact that it was not signed by the other party, that the party who had signed it was bound, and that parol evidence of conditions qualifying the delivery was not admissible.

### THE CONSIDERATION

**16. Compensation.**—Every agreement, unless under seal, must have some specified consideration, or payment for services rendered, stipulated in its terms in order to make it valid; for, although a contract may be properly executed and signed in the presence of witnesses, yet, if there is no consideration mentioned—that is, no remuneration to the party for performing labor or for furnishing material—the contract will not be legal and cannot be enforced in law. The remuneration may be money, labor, or materials, but there must be some statement to show that neither party is furnishing goods nor working without recompense from the other. In cases involving the enforcement of a contract, an effort is often made to prove that the entire agreement, or a portion of it, or some supplementary agreement, was without promise of consideration or remuneration and therefore of no force; and if the court takes this view of the matter, the contract cannot be enforced.

This is such an important item in assuring the validity of a contract or agreement that it is wise to commence every agreement, even if involving only a small amount, in somewhat the following manner:

"*For the consideration hereafter to be mentioned*_____ *A*_____ *promises and agrees to deliver certain goods (or do certain work) for*_____ *B*_____." The consideration should then be specified in detail elsewhere in the agreement.

The amount of the consideration matters little, for if a man is so unwise as to agree to build a house for a party in consideration of the sum of $1, the court will hold him to his contract, though he might be ever so much inclined to withdraw from such an unprofitable agreement.

**17. Sealed Contracts.**—Sealed contracts constitute an exception to the foregoing rule; for, in the language of the law, a seal "imports a consideration." Therefore, a seal placed in a legal manner after each signature on a contract will take the place of the stipulated consideration and make

binding all the promises contained in the contract, admitting no opportunity on either side to renounce these promises, or any part of them, even where no consideration is mentioned.

Formerly, the seal consisted of a drop of sealing wax, on which there was impressed the peculiar signature of the party concerned; or, in some cases, merely the end of his thumb was applied to the soft wax, and its imprint acted as a signet. In these days, however, the private seal is usually a piece of red paper affixed to the document with mucilage, and even this formality is not required in some states, which consider a blot of ink an adequate seal.

It can therefore be readily seen that it is always best to have the signatures to a contract under seal, as in this case there would be no possible opportunity for dispute in regard to the consideration by the parties, as in affixing their seals to the agreement they mutually consent to its terms, irrespective of a consideration.

**18. Entire and Divisible Contracts.**—All contracts may be divided in two classes, *entire* and *divisible*. **Entire contracts** are those that provide that a certain complete performance shall be paid for on its entire accomplishment, while a **divisible contract** is one that is complete in its several parts, the proportionate cost being paid in several instalments. In the entire agreement, the party performing the contract is not entitled to payment until it is completed, while in the divisible contract he may collect part payment at the completion of each stipulated part. A good example of a divisible contract is one that provides for the building of twenty houses at so much for each house. In this case, the contractor would be entitled to receive payment for any number he had finished, whether the entire twenty were completed or only one. A contract, therefore, that consists of an agreement by one party to perform certain work, complete in itself, and of an obligation by a second party to pay so much for the work, will not allow the first party to collect any portion of the entire consideration before the work is

completed; and, should he fail to complete his portion of the contract, he would be unable to collect *anything* for work done or material furnished, provided his failure to accomplish it was not due to any interference by the second party or by law or by the "act of God." If, however, the agreement should stipulate that payments be made at stated periods, as the work reached certain designated stages, a court may decide that owing to the terms of the agreement the contract becomes a divisible one, and that the builder or contractor can claim payment for such portion as may be completed, even should he fail to carry on the work to completion; but in all probability the courts of the different states would decide differently on this question of divisibility of contract, as it is frequently a difficult one to settle. As a building contract is divided more or less into a number of separate clauses and stipulations, relating to separate parts of the building, quality of material, workmanship, etc., it might be held in some courts that it is a divisible contract and that the contractor has a right to recover for labor performed and material furnished, on a portion of the contract.

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### THE ACCEPTANCE

**19 Accepting a Contract.**—Much uncertainty exists as to how soon a proposal should be accepted, and the courts have spent much time on cases involving this question. In one case, a person wrote to another offering employment and requesting a prompt reply. The offer was accepted by the person to whom it was made on the day following its receipt, and the letter of acceptance was handed to a boy to mail. The boy neglected to mail it until 2 days later. In the meantime, the person offering the employment had secured some one else to fill the place. In the suit that followed to compel the employer to keep to his proposal, it was held by the court that the time that elapsed between the offer and the acceptance was too long, and the proposal did not hold.

In the state of New Jersey, it has been held that where the offer specifies that it is open until a certain date, an

acceptance on that date is binding, unless the offer has been withdrawn previous to the acceptance.

Where the acceptance is made by letter, the question frequently arises as to whether it may be considered as taking place, and consequently the contract closed, at the time it is mailed by the party making it or not until it is received by the proposer. English law considers the acceptance made and the contract closed from the moment the letter of acceptance is delivered into the hands of the messenger that is to take it to the party making the proposal. This view seems to be held also in the states of New York, New Jersey, New Hampshire, Illinois, and Mississippi, but may be held differently in other states. The courts of Massachusetts, as well as the federal courts, hold that the contract is not binding until the acceptance is received by the party making the proposal. The posting of a letter of acceptance is usually considered as equivalent to its delivery to a messenger and binds the contract, even though it is not received by the other party. There are, however, exceptions to this, for, in one case where there was no proof that the postage had been paid, the New York Supreme Court decided that the acceptance was not complete. It should be remembered that the courts, in dealing with such uncertain questions as the foregoing, are usually governed by circumstances and the intention of the parties concerned rather than by abstract law principles and rulings.

The decisions of the courts in regard to telegraphic acceptances are quite varied, and, strange to say, are in some cases in opposition to their decisions in regard to acceptance by letter. The federal courts have held that an acceptance by telegram is binding the moment it is placed in the hands of a telegraph company for transmission; while, in acceptances by letter, as previously stated, they hold that it is not binding until received by the proposing party. Again, the New York courts hold that an acceptance by telegram is not binding until it is received, while, in regard to letter acceptances, they have decided in the same state that the acceptance is binding at the time it is posted.

**20. Extent of Obligation.**—All courts hold that bids must be accepted or rejected unconditionally. If a person in accepting a bid bases his acceptance on any conditions differing from, or contingent on, some change of the original proposal, the bidder is not bound by it, and may refuse to sign the contract; and, even should he remain silent, thus apparently accepting the bid, he cannot be held to it; and though the party made a subsequent unconditional acceptance, the contract would not be binding. Such conditional acceptances are of common occurrence among architects and others, who, on receiving bids for the performance of work, will write to the favored bidder that his proposal is accepted, on the condition that he will sign a satisfactory contract. Such an acceptance is not binding, and the bidder could withdraw his proposal if he saw fit and could not be held responsible.

In the acceptance of a proposal, the price named is often found to be a little less than the price asked by the contractor for doing the work; whether this is unintentional or whether it is a trick of unscrupulous parties, the fact remains that an acceptance in this way is not only in no way binding on the contractor, but actually releases him from his original offer. The assumption of the courts in regard to acceptances or proposals is clearly expressed by an Illinois court as follows: "A proposal to accept an offer on terms varying from those proposed amounts to a rejection of the offer, and a substitution in its place of a counter proposition, which cannot become a contract until consented to by the first proposer. The original offer thereby loses its validity, and is no longer pending between the parties, and it becomes an open proposition again only when renewed by the party who first made it; hence, the party who submitted the counter proposition cannot, without the consent of the other, withdraw or abandon the same, and then accept the original offer, which he had once virtually rejected."

**21. General Conditions.**—The architect usually prefaces the detailed specifications with matter covering all the

**general conditions** that are to be complied with by the contractor. (See *Specification Writing.*) This portion of the specification includes all general stipulations concerning terms of payments, time of completion, compliance with building ordinances, the obtaining of permits for water, blocking street and sidewalk, etc., together with other stipulations of minor importance. The contractor in bidding on the work accepts all the specifications, including the general-condition clauses, and on the acceptance of his proposal, he becomes bound in contract to all the terms of the specifications.

It is sometimes advantageous for an owner to accept unconditionally and promptly an especially favorable bid without the risk of a conditional acceptance, which would give the contractor a chance to withdraw. The owner in such a case runs no risk if proper general conditions have been embodied in the specifications, as a contract thus made is perfectly valid, and the builder in subsequently signing a formal contract that contains additional stipulations regarding insurance, time of payment, etc., usually does so with advantage to himself. Should the specifications not embody adequate general conditions, however, and the bid be accepted unconditionally, such a contract is equally valid, but the contractor can be held only for such stipulations as are mentioned in the specification. If the time of completion is omitted, the court will decide that a reasonable time is understood, though the legal idea of "a reasonable time" is likely to be at variance with that of the owner, much to the latter's dissatisfaction. Other terms of still greater importance may be found to have been omitted from the insufficient general conditions in the specifications, which will cause the owner much trouble and annoyance.

**22. The Position of the Architect.**—The architect sometimes oversteps his authority by accepting a proposal without duly consulting and being authorized by the owner. The extent of the architect's power in this direction, where the specification does not make exact and specific statements in regard to it, has not yet been determined by law, and the

zealous architect that accepts a bid in behalf of his client without consulting him or obtaining his indorsement to same is likely to be placed in an awkward position should the owner refuse to accept the proposition.

Therefore, if the owner is desirous that the architect should be empowered to accept immediately, at the time at which it is made, any proposal that would be to the owner's interest, he should authorize him in writing to do so, either giving him full power or limiting him to such an extent as he may see fit. Probably the safest and most satisfactory way of taking care of this matter is for the architect and owner to draw up an agreement by which the architect is empowered to accept or reject proposals, but only when such letters of acceptance or rejection are indorsed in writing by the owner. In such case, the general conditions of the specification should also state that the ordering of extras and the acceptance or rejection of proposals are to be in writing, either by the owner or by the architect, with the written indorsement of the owner.

The authority of the architect to accept bids and proposals is of vital importance to the contractor, who is liable to discover, too late, that he has made his contract through a person unauthorized by the owner. Therefore, in all cases where the slightest doubt exists, the contractor should ascertain *at once* that it is the owner's intention that the architect should be so empowered and that the architect's acceptance will have the owner's subsequent approval. In accepting a bid for the owner, the architect should exercise due caution in the wording of the acceptance, so that he may not himself become involved in its obligations, and his letter should plainly show that he is acting solely as agent for the owner by stating that "Being duly authorized by Mr. A. B. (owner), I hereby accept in his behalf your proposal"; or, "Through the instructions of Mr. A. B. (owner), I am authorized to accept for him your offer," accompanying the letter with the written authorization of the owner. Some specifications call for the ordering of extra work and the acceptance or rejection of bids by the owner only.

**23. Withdrawing or Modifying a Proposal.**—Although somewhat a matter of doubt, the general rule in regard to the withdrawal or the modification of a proposal is, that until accepted the proposal remains a proposal only, and may, up to the time of its acceptance, be withdrawn or modified. In the case of a proposal sent by letter, there is no doubt that the offer is open until the letter is received, and if the person making the offer can telegraph his withdrawal so that it will reach the proper person before the original proposal, the offer is nullified, and the parties interested in it are in the same relation as they were before the offer was made. But it has been held that if a person *receives* a proposal and immediately sends an answer accepting it, the offer stands valid, even though the party making the offer has despatched another letter in the attempt to withdraw it.

**24. Delivering a Contract.**—The formality with which the contract is delivered is of little importance, for if it is left at the place of business of the party concerned, the delivery is deemed complete, unless otherwise stated in the contract itself. A court in Illinois has held that one copy of a contract between the owner and the builder, being left in the care of the architect, had, to all intent and purpose, been delivered, and was binding on both parties.

Where several copies of a contract exist that are supposed to be alike in their terms and statements, but that as a matter of fact differ one from another, either party complying with the terms of the agreement in his possession is responsible only for the terms of his own copy.

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### MODIFICATION OF CONTRACT

**25. Modifying Contracts.**—Though formal contracts are generally made with due consideration and carefulness, and are looked on by the law as binding and enforcible on both parties, still it is human nature to be fickle and changeable in mind, and unforeseen events may transpire that will change the aspect of affairs entirely; hence, it becomes necessary to provide that an agreement may be

changed or modified in some manner, if so desired by both parties. This result may be accomplished either by *agreement* or by *waiver*. Where modifications in a contract are desired, such changes may be made by a mutual agreement between the contracting parties. This amendment, or modifying agreement, whether made at the time at which the formal contract is drawn up or later, has equal force with the original contract and is considered together with it. Many courts have held that such an agreement is valid, even when verbally made, unless there is a stipulation in the more formal agreement that no change or modification shall be made in the original contract unless in writing.

However, where the contract to be modified is with a corporation (especially if a public corporation), caution must be observed to see that all such changes and modifications are made with due formality; unless this is done, the contractor may have cause to regret his carelessness.

**26. Sealed Contracts.**—Since a contract under seal is regarded by the courts to be a more formidable instrument than a simple contract, owing to the formality with which it is executed, most courts are more severe in regard to any change or modification in a sealed contract, as shown by the following opinion of the court: "While a simple contract reduced to writing may be varied or changed in any way by a subsequent verbal agreement, it is otherwise as to contracts under seal, which cannot be varied by a mere parol contract, whether in writing or not, since such a contract is inferior to the original." Hence, as nearly all formal contracts, whether of corporations or individuals, are under seal, it is evident that great caution should be used, and that no attempt should be made to modify any such contract otherwise than in writing and with all the formality that attended the execution of the original document. Courts have held that "a sealed contract cannot be rescinded or released by a parol agreement." It is admissible, however, according to a decision given in the state of Illinois, to subsequently agree verbally to pay an additional price for the

same work as is stipulated in the written agreement, which agreement will remain valid in all particulars, except as to the price mentioned in the original document.

A contract that is not under seal may sometimes be changed or modified by an *implied agreement;* that is, should a man by his actions declare certain intentions, which vary from the original contract, and should these intentions be accepted by the other party, also provided there was no stipulation in the contract that required "that all changes from the original agreement should be made in writing," a court may hold that the implied agreement to change the original contract was the mind and intention of both parties and was therefore binding. Even when there is a clause in the original contract excluding any change by verbal or implied agreements, the court will, under some circumstances, uphold such changes, provided the intention of both parties can be proved beyond doubt to have been agreeable to such a change.

**27. Liability of Owner.**—That "silence gives consent" does not always hold good in law; in fact, very frequently the opposite is true, and such a view is usually taken by the courts in cases where it is held that the contract or portions of it have been waived by implication. If an owner should observe, in silence, deviations from the contract, it does not necessarily follow that he must accept or pay for such changes. In the first place, he may not be an expert in building matters, and again he may not fully realize the importance of such changes, though, if it could be proved that he favored such changes and assented to them, knowing that there would be additional cost attached thereto, the chances are that the court would hold him responsible. In regard to this, a Pennsylvania court held that "it is no excuse for non-performance, that the employer looked on while the work was in progress, unless there be evidence from which his assent may be implied."

**28. Invalidation.**—Many contractors are of the erroneous opinion that where there have been a number of changes

and modifications from the original contract, that such changes and modifications invalidate it, and they are privileged to ignore the original agreement in regard to price and may demand day-rate wages for the work. Such, however, is not the case, and all courts of justice will endeavor to obtain evidence to show what portions of the original contract remain intact and have not been mutually waived, and will enforce those portions accordingly. Where it is impossible, owing to the complications arising from numerous waivers and changes, to ascertain the terms of the original agreement, and in what relation they exist in regard to the actual work done, the court will endeavor to ascertain the reasonable cost of the work and material and award the contractor his claim on that basis, holding that, "when the original plans, on which the contract was founded, have, by mutual consent, been so substantially and materially departed from as to amount to a constructive abandonment of its terms and specifications, the case should be regarded as one of general employment, with an implied obligation by the owner to pay what the work and material are reasonably worth."

## CARRYING OUT THE AGREEMENT

### DEPARTURE FROM THE CONTRACT

**29. Substantial Fulfilment.**—Departure from a contract may be through either carelessness or wilfulness. The decision that a New York court has rendered in regard to such departure is well stated in a report as follows: "Parties to building contracts should be exact in the fulfilment of their agreements, even to the smallest particulars; and if they wilfully or carelessly depart from any one of them, they should incur the penalty, however severe it may be. But if a party, while acting in good faith, and with a determination to do all that he has contracted to do, unintentionally, and without any negligence, happens in some trifling matter to vary or depart from the terms of the contract, the law is not so severe and exacting as to deprive him of all compensation;

it ever regards the substantial rights of the parties, but overlooks trivial and unimportant matters."

To just what extent the court will hold a person for such deviations from a contract is somewhat undeterminable. It is, however, a foregone conclusion that the party will be held to the substantial fulfilment of his contract, the court deciding just what is meant by "substantial fulfilment."

The following case will show the position that the court took in regard to an unavoidable deviation in a contract for a block of stores. During the erection of the stores, the contractors discovered that the city had given them the wrong grade for the sidewalk, thus raising the stores about 8 inches too high. They notified the architect and a representative of the owner, who made no objection at the time. A balance on the payment due on the final certificate given by the architect was refused because of the mistake in the setting of the building. The case was carried to the Supreme Court, which decided in favor of the contractors as follows: "As there has been no wilful departure from the terms of a building contract, nor any omission in essential parts, and the laborer has honestly and faithfully performed the contract in all its material and essential features, he will not be held to have forfeited his right to remuneration by reasons of mere technical, inadvertent, and unimportant omissions or defects. * * * A substantial compliance with the contract is all that is required to entitle the builder to his reward."

**30. Determining the Responsibility.**—Deviations from the agreement due to the contractor's non-compliance with the specifications or drawing are often held to be the direct cause of poor or insufficient construction, resulting in damage to the building and loss to the owner. Where such is the case, it often becomes the court's duty to fix the responsibility, which, should the damage prove to have been due to the deviations from the contract, will very likely be placed on the contractor, even though there were no objections to them by the owner.

The following is an illustration of such a case: A contractor bound by an agreement, supplemented by plans and specifications, erected, or partly erected, a frame church; it was nearly completed when a severe gale blew it down. Subsequently, the contractor entered suit for the money due him; the owner held that certain deviations were made from the contract that were undoubtedly the cause of the damage, but he had, however, made no previous objections to the changes. The architect brought evidence to prove that the manner of construction in question, and from which the deviations had been made, was shown on the drawings, though there was no mention of it in the specifications. The evidence of the witnesses was rather unsatisfactory, as they differed in regard to the relative merits of the two constructions, also in their interpretation of the plans. The jury was instructed by the judge as follows: "If the contractors departed slightly from the plans, specifications, and drawings, and yet if such a departure did not diminish the strength of the building, nor contribute to its being blown down, such departure does not deprive them of their right to recover in this action, as the contract appears by the evidence to have been otherwise complied with." The decision was reversed, however, by the Supreme Court of Illinois, which said: "This position is untenable. The contractors had no right to depart from the working plans made part of the contract. If they did so, it was at their peril, and they would become guarantors as to the strength and safety of the structure. * * * The drawings were made part of the agreement. The contractors could only discharge themselves from liability by constructing the building in accordance therewith, unless a deviation was mutually agreed upon."

## ABANDONMENT OF CONTRACT

**31. Reasons for Abandonment.**—The abandonment of a contract occurs through the neglect of one or both of the parties to carry on the work for which they contracted. It may occur through the builder being unable to carry on the work or the owner refusing to longer be a party to the

agreement; or it may be that the interference of the law or some irresistible power prevented the fulfilment of the agreement. In any case, where the terms of the contract are well defined and have not been mystified by many changes and modifications, the court will endeavor to enforce them or such ones as may still be binding.

Should the work, when partly completed, be abandoned by the contractor without cause or without the consent of the owner, and should the builder refuse to proceed with it, the courts will not allow him a claim. He would not only be unable to recover a reasonable price for the completed work, but would be liable to the owner for damages.

If, however, the owner accepted the abandoned work and derived benefit therefrom by proceeding to complete the agreement under another contractor, the courts would be likely to hold that, on the completion of the work and the final payment to the second contractor, the first contractor would be able to recover the balance, if any, existing between cost of the work as done under the second contract and the amount of the original contract, deducting, of course, any damages that the owner might have sustained by delays caused by the abandonment of the work.

**32. Responsibility of Owner.**—The owner instead of the contractor is often at fault in carrying out the agreement, and in such a case the builder usually has no cause to complain of his treatment by the law. Where the owner is delinquent in the fulfilment of his agreement, the contractor may present his case to the court in two ways: (1) He may hold that the contract is still in force and claim compensation at the contract rates for the work that has been done together with a claim for damages that resulted to him, due to loss of profit on account of the owner's delinquency; or (2) he may claim that the contract has been abrogated, or annulled, and require reasonable payment for his work and materials furnished. Though he has either of these paths to pursue in prosecuting his case, the law clearly states that he cannot present evidence applicable to both, but must

accept one or the other and hold to it. He should be governed as to his choice by the circumstances surrounding his claim and the advice of his counsel.

In regard to a case where a contractor was prevented by the owner from proceeding with the contract, the New York Court of Appeals plainly stated the two grounds upon either of which a contractor could take his stand in presenting his claim. The opinion that was held by this court is as follows: "Where performance is prevented by one party to a contract, who terminates the agreement against the will of the other party, the latter may either sue for breach of contract, and recover as damages the profits he would have made if allowed to complete the work; or he may waive the contract, and bring his action on the common count for work and labor generally, and recover what the work done is actually worth; but in this case he cannot recover his profits on the unexecuted part of the work."

The owner may abandon his contract by failing to live up to his agreement or he may prevent the contractor from carrying out the work and fulfilling the agreement. Such a case as this was decided in Indiana. The owner of a building in course of construction having failed to pay the instalments on the work at the several periods when they were due according to the contract, was sued for damages by the contractor, who claimed that he had to abandon the work because of the non-payment of the instalments. The court's opinion in the matter was somewhat to the effect that if the owner had really prevented the contractor from fulfilling the agreement, then he should be able to recover as damages the profits that would have accrued to him, provided he had completed the job; but that the mere non-payment of instalments due on the contract before the work was finished did not constitute such prevention.

There are numerous other instances where it has been held that the contractor was unable to fulfil his part of the agreement on account of the owner failing in some way, either avoidable or unavoidable, to live up to the contract. In all such cases, where it can be proved that the contractor

was willing and ready to comply with his part of the agreement and was prevented by the owner from doing so, the courts seem to hold the opinion that he is entitled to recover not only for the actual work done but also for any profit that he would have received on the completion of the contract. For instance, should certain ironwork be ready for a building at the stipulated time, and should the building, which was not in a condition to receive it, burn down, the parties furnishing the ironwork would undoubtedly be able to recover the contract price, less the cost of erection; for they had completed their agreement as far as it was possible and within their power, further completion being impossible, owing to the failure of the owner to have his building ready in time.

**33. Death of Either Party.**—The death of the contractor ends the contract unless some provision is made in the agreement by which his heirs or executors become responsible for its completion, and the court in Missouri has decided that no lien can be taken out against the building for work or materials thereafter furnished under the contract. The contractor seems in this case to have the advantage, as the death of the owner does not affect the contract, because it is binding against his estate.

Where the contracting parties wish to guard against any of the foregoing contingencies, all that is required is the insertion of a clause in the contract that will convey their mutual intent and meaning in regard to the matter considered, and the court will see that it is enforced irrespective of general principles and precedent.

**34. Abandonment Not Always Justified.**—Before taking so serious a step as to abandon a contract, the contractor should be sure of his position and determine whether he is justified in such a proceeding, for, as expressed by the Supreme Court of Missouri, "A mere breach of contract does not entitle the other party to stop work and recover for unperformed work. He might stop work and recover for what he has already done, but not for what remained to be

done. To recover for that, he must have been prevented from going on by the unauthorized interference of the other party. The measure of damages on the contract, in such cases, is the contract price, less what it would cost to complete the work."

**35. Forfeiting of Contract.**—It sometimes occurs that one of the parties of a contract may find it impossible to fulfil the terms of the agreement owing to the conduct of the other party. In such a case, he should notify the other party immediately, declaring his unwillingness to be bound by the contract, or at least by certain stipulations in it; if he fails to do this promptly, it may be held that by his silence he waived his right to do so. For instance, a contractor may have been unreasonably delayed and interfered with by the owner's demands requiring a number of changes, or by the owner's withholding his decision on certain important questions, which prevented the contractor from proceeding with the work and completing it in the specified time. This being the case, the contractor is entitled to rescind the agreement, but he should do so at the time, or it may be held that he has waived his right to do so.

Instead of the owner being at fault, the contractor may fail to have the building finished at the stipulated time. This might give the owner the power to rescind the contract, but he should exercise this right at once; for should he fail to do so, and permit the contractor to proceed with the work, it would very probably be held that he had waived his right, and all that he could claim would be damages for injury due to the delay caused by the failure of the contractor to complete the agreement at the specified time, as provided in the contract.

Before entering on an agreement, the contractor should ascertain whether the plans and specifications call for work that can actually be constructed and whether the conditions are such that they can be carried to completion. Anything that is not clear to him from the plans or specifications should be explained to his satisfaction by the architect;

otherwise, if he should find, after signing the contract, that he cannot in any possible way carry out the work as shown, the court will very likely hold that he, being a responsible builder, should have known whether the plans could be carried out and that he was bound by the contract.

**36. Reinstating Contracts.**—Any contract that has been declared forfeited under the terms of the agreement may be reinstated by the mutual consent of the parties concerned, in which case they will no longer be governed by the annulment.

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## FRAUDULENT CONTRACTS

**37. Statutes of Frauds and Limitations.**—In the several states, there are codes of special laws known as the "Statutes of Frauds and Limitations." The particular clause in these statutes of interest to those engaged in building operations is here quoted from the statutes of Maine and reads as follows: "No action shall be maintained upon any agreement that is not to be performed within 1 year from the making thereof." That is to say, no contract shall be valid (unless in writing) that calls for an accomplishment of certain things that cannot be fulfilled within 1 year from the date of making the contract. The decision of a New Hampshire court is interesting in that it held that if the performance of the contract could be accomplished within 1 year (even though it was improbable that it would), the contract was not within the statutes and did not have to be in writing. The language of the court in this case was: "The Statute (of Frauds) does not apply to any contract, unless by its express terms, or by reasonable construction, it is not to be performed—that is, is incapable in any event of being performed—within 1 year from the time it was made. If by its terms, or by reasonable construction, the contract can be fully performed within 1 year, although it can only be done by the occurrence of some contingency by no means likely to happen, such as the death of some party or persons referred to in the contract, the statute has no application, and no writing is necessary.

If the agreement can be fully performed by either of the parties within 1 year, and it is so performed, the agreement of the other party is not within the statute, though it may be impossible to perform it within 1 year."

A case once arose in New York where the question involved was as to whether the terms of a verbal agreement prevented the possibility of the contract being completed in 1 year. The contract was made about 15 months before the date on which it was verbally agreed that the building should be completed. Some misunderstanding in regard to the agreement arose, and, in the suit that followed, the defendant claimed that the contract was invalid under the "Statute of Frauds." The claim was, however, denied by the Supreme Court, which rendered the following decision: "The agreement set forth in the declaration in this case is not for the building of a house after the expiration of 1 year, but is to be performed at the farthest within 15 months. There is nothing in the agreement prohibiting the defendant from completing the contract within 6 months, or a shorter period. Suppose he had done so, and sued the plaintiff for compensation for his labor and materials found, would it have been permitted to the plaintiff to have said that the contract was not to be performed within 1 year, and therefore it was not obligatory on him? Most clearly not. And if obligatory on one party, it is equally so on the other. The defendant might have performed the contract within 1 year, and it is therefore not within the statutes."

**38. Fraudulent Contracts.**—It is generally supposed that where a man has signed a contract he is held responsible and there is no escaping its conditions. However, if it can be proved that fraud was used in gaining his signature or that he was wilfully deceived in some manner, the court will deal fairly with him, and, as far as possible, will usually prevent the fraudulent party from gaining an advantage; for the court fully realizes that no matter how carefully a man may conduct his business transactions, no amount of care will protect him against frauds. The court, however, will

have little patience with any one that, through carelessness, allows himself to be imposed on. Even in cases where no fraud is intended and a mistake exists, if it can be proved that no usual amount of care could guard against it, the law will make an effort to correct the mistake and release the innocent parties if it can be done without dealing unjustly with the other parties, who may have been more careful.

When a party, before commencing the work, discovers that he has entered into a contract that misrepresents the amount of labor he is to perform or materials he is to furnish, he should, in order to avoid trouble, notify the other parties immediately that he repudiates the contract. If he should proceed with and perform the work, knowing that the amount to be done had been misrepresented to him, he would be unable to obtain more than the contract price. Where a stipulation in a contract, such as the time of completion, is misrepresented, or a mistake in the statement has been made, it has also been held that the balance of the contract remains intact, and that only such parts as are affected by the erroneous stipulations are invalidated. *A contract made on Sunday is invalid.*

## COMPLETION OF THE CONTRACT

### ACCEPTANCE OF THE WORK

**39. Completion of Work.**—The last, or final, stage in the fulfilment of a contract is the completion and acceptance of the work, which is often fraught with more misunderstanding and dispute than any other portion of the transaction.

Most contracts stipulate that the work shall not be deemed as completed until it has been accepted by some designated party, which is usually either the architect or the owner. If the architect accepts the work, he should furnish a certificate to the builder to that effect. Should the owner be the one who accepts the work, he should do so in writing. In some cases, it is required that both the architect and the owner should accept the work. It is well to stipulate in the

contract that all work shall be subject to the approval or satisfaction of the specified architect or architects. This clause is valuable in that it leaves all unsettled matters in regard to workmanship and materials to the architect's decision and sustains his authority as a final judge. If his judgment has been given in good faith, and with an intention to deal fairly with both his client and the contractor, there will be no necessity for subjecting the controversy to settlement by arbitration or trial by jury, for the court nearly always accepts the opinions and decisions of an honest and conscientious architect.

Where it has been stipulated in the agreement that "the work shall not be considered complete until certified to by the architect," most courts will hold (though there are exceptions to this rule) that the contractor must present a certificate from the architect before he will be able to claim that the contract has been completed. Even though the contract especially stipulated that the architect's certificate was to be binding and conclusive on both parties, such is not always the case; for, if it can be proved that the architect fraudulently or unscrupulously withheld it, or, in failing to grant it, was not acting according to his best judgment and was prejudiced against the builder, intending to oppress him, the court may hold that the architect's certificate is not necessary to the completion of the contract.

The architect is always subordinate to the contract. He cannot cause work to be done at variance with the stipulations in the contract; neither will his certificate for work that does not fulfil the requirements of the agreement be valid, and, though he has the power by the terms of the agreement to reject or accept all work as he may see fit, he is not authorized to reject any work that is done according to the agreement nor accept any work that is not.

The usual certificate is a blank filled out by the architect, which states that, in the opinion of the architect, the contractor is entitled to so much money for work done since the last certificate issued or since the beginning of the work. The certificate usually calls for about 90 per cent. of the estimated

value of the work done during the previous period, and also states that it is an expression of opinion and does not imply legal responsibility. This certificate might well state also that its issuance does not imply the acceptance of any work not in accordance with plans and specifications.

**40. Accepting the Work.**—The acceptance of work by either the architect or the owner is not always a waiver of the defects that may exist in it; though it may sometimes be implied from the owner's conduct, where the defects have been obvious and he has made no objections to them, that he accepts the work. But, should the defects be concealed, neither the owner's virtual nor formal acceptance will prevent him from recovering on the ground that the contract was not completed. In regard to this, the following view is generally taken by the courts: "Notwithstanding acceptance, virtual or formal, unless expressly made in full discharge of the contract, if the work or materials are not as contracted for, the owner may recover damages sustained in consequence."

A case involving this principle occurred in Georgia about the year 1854. It seems that a contractor undertook certain work for the trustees of a university. The contract was made in regard to some repairs and the remodeling of a certain building, and required that the contractor should "remove certain walls and put in such pillars as might be necessary to support the ceilings"; also, that the work should be completed "in a neat and workmanlike style." The repairs and alterations had been completed and virtually accepted by the trustees, who were present during the time the work progressed and had made no objections to it. About 18 months afterwards, one of the wooden girders put in according to the contract failed, and this so injured a portion of the ceiling that extensive repairs were necessary. In the suit instituted by the trustees for damages, testimony was introduced by the defendants to the effect that several days previous to the accident a leak had been discovered in the roof, and that the leakage so increased the weight on the girder as to cause it to fail. The plaintiffs proved, however,

that the chestnut girder was of a brashy nature and knotty, and further expert evidence was introduced to prove that it was of insufficient strength and that the ceiling should have been supported by several more posts.

**41. The Right to Recover.**—The lower courts decided in favor of the defendants in the foregoing case, but the decision was reversed by the Supreme Court, which held "that the fact that the plaintiffs received the work, and paid for it, does not affect their right to recover in the slightest degree; it is not a circumstance to be considered against that right. They are entitled to recover, unless they, at the time of the acceptance, knowing of the defective and neglected work, and of the non-compliance by the defendants with their contract in all respects, expressly waived a performance of the contract, and agreed to pay the stipulated prices, notwithstanding; all of which must be made affirmatively to appear by the defendants, to be available to them as a defense. * * * The evidence in this case falls very far short of this. Was the attention of the plaintiffs called to the fact that an important girder was brashy, knotty, and entirely incapable of supporting the weight resting on it? * * * Their attention was not called to it, and they could not see and examine the girder for themselves, for it was concealed from their view by the floor on one side and the overhead ceiling on the other."

One of the claims of the defendants was that the insufficiency of the pillars was self-evident, and that the plaintiffs must have observed the defect. In reply to this, the court said: "True, they could see the number of pillars, but they were not informed as to the number necessary. The defendants undertook specially, in their contract, to put in 'such pillars as might be necessary to support the ceiling'; they were to judge, and to judge correctly, at their peril. * * * The idea that they (the plaintiffs) were waiving any of their rights under the contract, never entered their minds; * * * they accepted the work because they believed that the defendants had complied."

**42. Occupancy or Possession.**—There is a general understanding among builders that if the owner moves into or occupies the building constructed under the contract, an acceptance of the work is implied. Such, however, is not always the case, as many decisions of the courts show. Even should he pay the contractor in full without demanding the architect's certificate or otherwise formally accepting the building, it could be held that no implied acceptance was meant.

In a case where a contractor had failed to comply with some material part of the contract, the parties for whom the work was done moved into the building and refused to pay the balance due the contractor; the contractor entered suit on the ground that the parties, by occupying the building, virtually accepted the work. The New York Court of Appeals, however, held "that if a contractor has neglected, and refuses, to complete his contract in a material point, it does not follow that the owner waives its performance by taking possession of, and occupying, the building in its defective condition." The court also said: "An owner is not put to so absurd an alternative as either to lose and abandon his building, worth perhaps $10,000, or to occupy it at the peril of paying for work not performed, or of waiving thereby the performance of any substantial covenant of the contractor." The New York courts also hold that "the occupancy of a building is not a waiver of the plain requirements of the contract."

## PENALTIES AND PREMIUMS

**43. Liquidated Damages.**—The owner is often put to considerable inconvenience, and in some cases needless expense or loss, by the delinquency of the contractor to have the work finished at the stipulated time. For instance, it may be that the parties are having the building erected for their own occupancy, and that the lease on the property that they are occupying expires about the same date as that on which the contractor is to have the new building completed,

or it may be that the building is to be rented to tenants that expect to occupy it by a certain date, and have made arrangements accordingly. Hence, it is evident that the owner or owners may be placed in a very awkward position and perhaps compelled to sustain considerable financial loss, entirely due to default of the contractor in not having the work completed on time.

To guard against such a contingency, it is usual to provide in the contract, that the person doing the work shall pay a certain sum of money per day to the owner for each and every day beyond the stipulated time of completion that the work may remain unfinished. All contracts usually specify that this stipulated sum of money or forfeiture shall not be regarded as a penalty, but is to be considered as **liquidated damages** (liquidated damages simply meaning damages that are fixed by the terms of the contract, as opposed to unliquidated damages, which are decided on subsequently by jury or other means). The Supreme Court of Alabama, in regard to such forfeitures, says: "The court must ascertain whether the true intention of the parties was to afford fair and reasonable compensation for the loss sustained, in which case it is a real penalty, which can be apportioned to the actual loss sustained; or liquidated damages, which must be suffered without regard to actual injury resulting from failure to keep the contract. The tendency of the law is to regard the stipulations as a penalty, rather than as liquidated damages, and, if there is any doubt as to the intention of the parties, it will be so construed; and even if the stipulation is for payment of a sum in gross in case of failure to perform, the sum stated will still be considered as a penalty." It would seem from this decision that there is a difference expressed between a penalty and a forfeiture for liquidated damages. A penalty is regarded merely as a sum to be forfeited, out of which the actual damages are to be taken, while by liquidated damages is meant a sum usually agreed to by the contracting parties as the amount to be considered as actual damage. The purpose in regarding the forfeiture as liquidated damages is to avoid subsequent dispute as to

the amount of the real loss suffered by the owner; and it is commonly thought, where expressly stipulated that the forfeiture is to be considered as liquidated damages, that the courts would not interfere to invalidate the valuation that the parties had mutually agreed to in the contract.

**44. Just Compensation.**—Many of the highest courts in the land, however, look on all time forfeitures as mere penalties out of which the actually ascertained damages are to be taken, whether they are stipulated as liquidated damages or not. In such decisions, the owner is entitled to only such a sum as would fairly represent the loss he had sustained, and no unreasonable forfeiture could be collected.

Should it be proved that the owner endeavored to make profit out of a forfeiture clause, even though the forfeiture each day was qualified by the phrase that it was to be considered not as a penalty but as liquidated damages, it is more than probable that the court would not uphold him, and would decide, as previously stated, that all he was justly entitled to would be damages amounting to the actual loss he sustained by the default of the contractor. This was decisively settled by the Supreme Court of Michigan, which formulated the following rule: "The principle at which the law aims in awarding damages is that of just compensation for the injury sustained; and the parties will not be permitted by express stipulations to set this principle aside."

Even should there be no stipulation in the contract to the effect that the contractor was to forfeit a certain sum as liquidated damages for each and every day the work should remain unfinished beyond the specified time, the owner would be able to recover, as damages, any loss that he could prove to have actually existed through the default of the contractor.

**45. Forfeiture Clause in Contracts.**—The following assumed case will illustrate to what extent the contractor is responsible in regard to the forfeiture clause in contracts. An owner contracts with a party for the erection of a summer cottage and stipulates in the contract a

reasonable forfeiture, to be paid by the contractor, provided it is not completed by a certain date, thinking that in this manner he will stimulate the builder to an extra effort. The builder fails to have the cottage done on time, and suit is entered by the owner for the amount of the forfeiture, which is out of all proportion with the importance of the job. The court will very likely hold that he can recover only the day rent of the cottage for each and every day over the specified time, provided the delay has not been serious; and if the time of completion has so far exceeded that specified that the owner has been compelled to abandon the cottage for the summer, the court will more than likely award him damages to the amount that would be required to rent a similar cottage for the season. Again, it may be that the building is to be rented, and for every day over the time specified that the builder fails to have it completed the owner is out just so much rent; in that case, the court will award him the amount that he has lost in rents, with any other loss he may have sustained through invalidated leases with the tenants. Therefore, since it is very generally accepted by the courts that in any case only just damages can be recovered, the best thing that the owner or architect can do in stipulating the terms of the contract, where it is important that the work should be completed by a specified time, is to carefully estimate, as nearly as possible, the actual damage that will occur from the non-completion of the contract, and to add to this a reasonable margin for unforeseen contingencies. This amount should be obtained in a sum of so much a day, and should be inserted in the contract as a forfeiture clause for liquidated damages; then, were disputes to arise, this forfeiture clause would be upheld by the law if the amount was reasonably correct.

**46. Unfinished Work.**—The stipulation providing that a forfeiture shall be paid for delay in the completion of the building is of some advantage to the contractor; though, at first sight, it might not appear so. This advantage is due to the fact that, as a stipulation is made in regard to the

forfeiture of a sum of money for each day that the work shall have been delayed beyond the contract time, and such a forfeiture is agreed to by the builder in signing the contract, the owner must necessarily waive his right to rescind the contract on the ground that the work was not completed on time. If, however, no such forfeiture clause exists, the failure of the contractor to have the building finished in the specified time is a breach of the agreement, and the owner may rescind the contract. Thus, the builder, or contractor, loses his final payment for the unfinished portion of the work. Should the owner, however, fail to notify the contractor of the termination of the agreement on the day specified for the completion of the work and allow him to proceed with the job, he cannot do so subsequently, as he has waived his right in this direction. The courts have ruled, in regard to this, that "when the owner permits the contractor to continue work after the expiration of the time within which the work was to be completed, he waives the right to rescind the contract on that ground, but does not thereby waive such damages as he may have sustained by reason of the delay."

**47. Reasonable Time.**—When no specified time for the completion of the work has been provided in the contract, it might be supposed that the contractor could delay his work indefinitely; such, however, is not the case, for a **reasonable time** is always presumed to be understood, though just what constitutes a reasonable time is somewhat uncertain and will depend on the jury before which the case is tried. If would not be safe, therefore, where there is no time stipulation in an agreement, for a contractor to delay very considerably the completion of the work; for, should the owner's patience fail, and he bring suit, the jury is likely to decide that the contractor had been allowed more than a reasonable time for the performance of the work, and the owner could recover damages for the delay over the time held by the jury as being reasonable.

Should the owner waive the stipulation in regard to the time of completion, or his claim for damages due to the

delay, or any other stipulation or clause, it must not be thought that the other provisions in the contract are waived, or that the contract is invalidated thereby. Such is not the case, and it may be expressly stated that the waiver of one stipulation of a contract does not affect the others.

**48. Delays.**—It is not unusual for the contractor that has agreed to have the work completed by a certain date to be delayed, and thus prevented from complying with the contract, through the fault of other contractors or of the owner. Where the delay has been caused by the default of other contractors, it seems to be held, as a rule, that the contract is subjected to implied modifications in regard to the time limit, an extension of the time equal to the delay caused by the other's fault being allowed to the principal contractor. This is substantially the same as was held in Illinois when the court stated: "Where one contracts to do certain work in such a way as not to delay other contractors, and to have it done on a certain day, and, by delays of other contractors, is unable to commence it until near the time of completion, he is still held to the contract, except as to time of completion, and for unnecessary delay on his part will be liable to his employers for damages."

Should the delay be caused through the fault of the owner, the contractor will not only be entitled to an extension of the time limit, but should he on the same account be put to additional expense, he will be able to hold the owner for such, unless the contract provides that the owner shall have the power to postpone or delay the work as he may see fit. When, however, the contractor finds that the owner or the other contractors are causing him delay and additional expense, he should notify the owner to that effect immediately, so that the owner can take steps to prevent the delay, or so enjoin the other contractors that they will remove the cause of the complaint, and hence the additional expense to the complainant.

**49. Non-Fulfilment of Contract.** — The owner, on finding that the work is not progressing rapidly enough, due

to neglect or inability on the part of the contractor, may, on giving due and proper notice to that effect, employ other parties to finish the contract, and in due justice to himself may, in order that he will not lose the advantage of the contract, pay these parties out of the contract price or charge the cost to the original contractor. Carefully written contracts usually provide in some manner for this contingency and make special provision in regard to the terms and circumstances that will authorize the owner to take such a step. The rights of the contracting parties in regard to this are clearly expressed in the following decision of the Supreme Court of Illinois: "If one party induces the other to believe that he has withdrawn from the contract, the other need not wait for the day of performance before making new arrangements, nor does he lose his remedy against the delinquent party by providing at once against losses likely to arise against such delinquencies."

The owner, in taking the work out of the delinquent contractor's hands and completing it himself, or through another contractor, must see that it is done within a reasonable expense. In fact, since the original contractor has to pay for the subsequent work, his money is really being used, and the owner should guard it as he would his own, avoiding extravagant or wasteful expenditures; for, should it be proved that he was careless in this respect and attempted to charge an unreasonable sum against the original contractor, the courts would not uphold him. If the owner choses, he may complete the building by day work, or he may make arrangements with another contractor to do so at a reasonable price; but he must keep a careful account of the actual expenditures, and charge nothing else against the original contractor.

Should the owner, after rescinding the contract according to the provisions in it, or on good and sufficient reasons, find that some of the original contractor's work is defective, he may make good such work, and charge the expenditures to the cost of completing the building. If there are materials on the site of the new building furnished by the original

contractor, and these materials are good in every respect and substantially as specified or contracted for, the owner is bound to use them in completing the work, and thus avoid charging the original contractor the cost of such materials, which may be of less or no value on other work.

In well-drawn contracts, however, provision is generally made that where the contract is forfeited and materials are left on the ground by the original contractor, they shall be used at the discretion of the owner or the architect.

Even where the contract has granted them the authority, the owner, and the architect as well, should carefully consider the circumstances and all the stipulations relating thereto before taking so serious a step as the forfeiture of a contract. Where no provision has been made in a contract with regard to the contingency of its forfeiture, the owner or the architect, as the case may be, should, when there is good reason to do so, notify the contractor that he has forfeited his right to complete the contract. The owner should also endeavor to show an intention of finishing the work according to the terms of the contract, at a minimum cost to the original contractor, and protect his interest in every possible way.

**50. Terminating a Contract.**—An architect was once authorized in a contract to terminate it if he should see fit; the contractor applied to court for a decision as to whether the architect had a right, under the circumstances, to forfeit the contract. The architect held that he had the right to declare the contract forfeited under the terms of the agreement; but the court decided that the contractor had the privilege to apply to the court for its decision as to whether the architect was justified in terminating the contract.

The termination of the contract and the completion of the work by the owner or his representative somewhat changes the position of the architect. In a case where a subcontractor had entered suit and the work was being finished by other parties designated by the owner, who had rescinded the original contract, a New York court held that the certificate

of the architect, which was required under the original contract before payment would be made, was not required, as the owner was now his own contractor.

**51. Premiums.**—Premiums are sometimes offered where the work is of special importance, and are stipulated in the contract as being payable to the contractor at so much a day for each and every day that he shall have the work finished before the specified time. Such a clause is sometimes included with a liquidated-damages clause. Where such premiums are stipulated in the contract and the owner in some way unreasonably delays the work, thus preventing the contractor from completing it before the specified time and depriving him of the premium, the courts have held that he can recover, provided he can prove that he would have finished before the specified time if the owner had not interfered.

The difficulty, however, in such cases is in determining just how long before the stipulated time the contractor would have finished if the owner had not interfered. This at best is mere guesswork, and depends on the circumstances surrounding the case. Where the stipulated premium amounts to a considerable sum of money for each day gained, the importance of correctly determining the exact number of days may readily be seen. For instance, in one case the stipulated premium was $500 a day for each and every day the contractor should have the work completed before the specified time; the owner interfered, and the contractor entered suit, claiming that without such interference he would have gained considerable premium. The court decided that he could have finished 30 days before the stipulated time and awarded him the $15,000 due him.

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## EXTRA WORK

**52. Extra Work: Verbal Understanding.**—In a case brought before the Superior Court of Massachusetts, where the written contract stipulated that no extra work would be paid for unless ordered in writing, and where the contractor had done extra work on verbal orders and been refused

payment, the court held that "attempts of parties to tie up by contract their freedom of dealing with each other are futile The contract is a fact to be taken into account in interpreting the subsequent conduct of the plaintiff and defendant, no doubt, but it cannot be assumed, as a matter of law, that the contract governed all that was done until it was renounced in so many words, because the parties had a right to renounce it in any way, and by any modes of expression they saw fit." In expressing the foregoing decision, the court was undoubtedly governed by the facts of the case, which were that most of the work was done after the original contract was practically completed, and the extra work, which was done during the completion of the original contract, had been verbally agreed to and payment had been promised for the same. Hence, in this case, the point to decide was not so much the setting aside of the stipulations requiring all extra work to be ordered in writing as it was whether the stipulations in the original agreement applied to subsequent and apparently independent work.

A similar case came before the Federal Court, where suit was entered by a contractor to recover payment for extra work, which the government had refused because the contract stipulated that no extra work should be paid for unless agreed on in writing. The court held that such a clause was inserted by the government in order to limit the powers of the architect and the superintendent, and did not bind the parties in such a manner as to avoid a verbal or implied agreement for extra work. The judge further stated: "Courts cannot transmute a contract into a statute of frauds, nor attach to the agreement of the parties the irrevocable mandatory attributes of a statutory provision. A provision in a written contract declaring that no claim for extra work shall be made unless it was required and agreed upon in writing, is merely a condition, which may be waived by a subsequent oral agreement." Also, "Where a public agent requests a departure from an express contract, and the change ordered is of such a nature that he may reasonably suppose that no additional expense will be caused

thereby, the contractor is bound to speak, or he will be deemed to have consented to make the substitution at the contract rate. But where the change is of such a nature that it must necessarily involve additional cost, no such notification is necessary, and the contractor will recover reasonable compensation."

It would not be safe, however, to omit the clause in the contract that provides that "no extra work shall be paid for unless ordered in writing," for many courts have held that such a clause cannot be broken with impunity; and where it can be proved that the real intention of the parties concerned was that all such orders for extra work should be made with due formality, the contract is valid and will be upheld by the court.

**53. Extra Work: Written Agreement.**—Often there is found in the contract two apparently contradictory clauses: one that implies that no extra work shall be paid for unless ordered in writing, and another that states that the engineer or the architect shall have power to direct additions to, or alterations in, the work. The court has decided, however, that in such cases the latter clause does not in any manner affect the validity of the first. A New York court refused to admit evidence where the contract provided that "no extra work shall be paid for if not ordered in writing," unless the parties could furnish the written orders for such work.

In emergencies, where the safety of the building is at stake, and the architect or the engineer may deem it necessary to verbally order extra work done to eliminate such danger, the contractor would more than likely be able to recover payment for the extra work, even though there was a stipulation in the contract that written orders would be required for all extra work. In order to illustrate in what light such a condition of affairs is held by a court, the following may be of interest: A county commission in Indiana appointed a supervising engineer to superintend the erection of a certain bridge to be built under contract. During its erection, the superintendent thought it advisable to do the work in such a

manner that a considerable amount of extra masonry and filling was required. The contractor being unable to collect for the extra work entered suit. The county commission claimed that the county could only be bound by the contract, and were responsible for nothing outside of it. The case was carried to the Supreme Court, which based its decision on the statutes applying to the erection and repair of bridges, which set forth that "for the erection of any such bridge, the said board shall appoint one or more discreet persons as superintendents thereof," and further authorized that the superintendent should have the power to receive proposals, let contracts to the lowest responsible bidder, and require surety for the performance of the agreement. On this, the court found that "it is thus seen that the superintendent has power to let contracts for the construction of bridges, and to superintend the work. We think that this makes the superintendent the agent of the county for the purpose of the construction of the bridge or bridges, and that he may bind the county by requiring work to be done beyond that contemplated by the contract. Such authority in the superintendent is necessary for the county, in order that the structure may turn out to be substantial and lasting; and it is proper, in order that the contractor employed to perform the extra work may have a remedy therefor. If it should be foreseen by the superintendent, after the letting of the contract, that the work performed or contemplated by it would be insufficient or defective, the county might be greatly the loser if he could not require such additional work as would make it substantial and permanent, and bind the county therefor." It should be distinctly remembered, however, that unless the contract expressly stipulates that an architect has power to order additional work, the owner will not be held responsible for payment for such work, unless, as stated in the preceding paragraphs, it is absolutely necessary for the safety of the building and well being of the owner. In such a case, the court, if passing favorably on the question at all, will very likely do so on the basis that the architect acted as the owner's agent, and as such had

authority in an emergency to order such extra work to save the owner from loss, and hence the owner would be required to pay for such work.

**54. Advantage of Observing Extra-Work Clause.** All parties concerned would be better off if the contract that expressly states that there shall be no extra work done unless ordered in writing were lived up to, for if such a stipulation is once broken, carelessness in this respect is likely to become the rule rather than the exception during the whole of the building operation, and when the settlement comes to be made there is trouble for both the owner and the contractor. It may readily be understood how, during a large building operation, where there is looseness in carrying out the contract stipulations for extra-work orders, there may be numerous misunderstandings in regard to the various verbal orders given. These misunderstandings frequently arise from the fact that, in the hurry and bustle of a modern building operation, the average contractor is likely to interpret the slightest wish or action of the owner as implying an order for extra work, and as the operation proceeds, the careless owner continues to express his wishes for the most trivial variations, not realizing that the possibly unscrupulous contractor is carefully keeping account of all such suggestions and figuring on collecting a good price for them as orders for extra work. Thus, a contract, when broken in whole or in part, is difficult to enforce again. In making the final settlement, the owner is often inclined to admit that certain of the verbal orders were valid, but to claim that others were not, because of no written order being furnished. This very contradictory condition of affairs is obviously unjust, and would be looked on with disfavor by any court, which would be likely to decide, as in a New York case, that "a written contract may be waived, either in whole or in part, by parol, and after it has been thus waived by one of the parties, neither he nor any one acting under him can reinstate it."

**55. Estimating Charges for Extra Work.**—In estimating the amount to charge for extra work, contractors are

likely to base their estimate at day wages; hence, it would be well to stipulate in the contract either that all extra work shall be paid for at contract prices or furnish some schedule on which the charge for extra work may be based. When the extra work is of the same nature as that specified in the contract, the usual custom is to itemize the estimate from which the contract has been made up and to charge all extra work accordingly. Usually when this is done the itemized schedule of prices for labor and materials is affixed to the contract and agreed to by the parties concerned as the basis on which all extra work is to be charged.

In a like matter to that in which extra work is ordered, omissions are sometimes made from the work required by the original contract. Where this is done, the amount of the deduction to be made from the contract price, on account of the omitted work, should be immediately agreed on with the contractor, and he, in deciding what will be a fair price to allow, must be governed by any stipulation bearing on the subject in the contract, and must also, if he wishes to deal honestly with himself, take into consideration any cost that may be caused by such omissions, which should be deducted from the allowance to be made to the owner.

Where no stipulation in regard to allowances for work omitted is made in the agreement, the views of the courts are very changeable as to whether the owner is entitled to any deduction. One court has handed down an opinion that "the defendant (meaning the owner) had a right to demand the very work specified, and if it accepted anything less as sufficient for the purpose named, has no right to insist that a rebatement should be made for that reason"; whereas, another court has held that "the owner is entitled to a reasonable compensation for work which has, by his desire, been omitted." It is evident, then, that all parties concerned would be better off if stipulations were made in the agreement in regard to deductions to be made from the contract price for work omitted, and on what schedule the prices by which the value of such work is to be estimated.

**56. Decision as to Estimating.**—A case often comes before the court that requires a decision as to how work shall be estimated. In such cases, the court is generally guided by the local custom in figuring such work, provided that this custom is well established among people engaged in building operations, generally understood by them, and reasonable in its results.

The Supreme Court of Missouri is agreeable to the custom that provides that in estimating for the laying of *stonework*, the door and window openings shall be measured as solid, and the corners measured twice. This same view is held in Maryland, with the further provision in regard to curved work, that it should be measured at one and one-half times its actual length. However, on account of the widely differing customs that sometimes exist in the same state, too much dependence should not be placed on the legal validity of any one of them.

**57. Plaster Work.**—A New York court once admitted evidence to prove that the custom among plasterers in Buffalo was to charge for the entire surface of the walls, without making any deductions for the window and door openings, cornices, or baseboards. A Pennsylvania court took another view of such work by saying: "A custom of plasterers to charge half the size of the window openings, at the price agreed on for the work and materials, is unreasonable and bad."

**58. Brickwork.**—Where brickwork was to be paid for by the thousand "in the wall," disagreements have arisen as to the method of counting the number of bricks, and, though the custom of allowing from twenty to twenty-two new bricks to a cubic foot of wall, or to a superficial foot of 12-inch wall, is well established among masons and bricklayers, the Supreme Court of Tennessee, in deciding such a case, would not admit it as evidence, and seemed to favor the actual count of the number of bricks used.

**59. Excavating.** Before a contractor makes an agreement to do "earth excavation" at so much a cubic yard, he

should always ascertain the nature of the soil, as otherwise he may discover when too late that the bulk of it is through hard pan, which will cost much more to move than ordinary earth, and which he did not figure on. If he should appeal to the court in an attempt to collect payment for the greater amount of work involved, he would more than likely find that his claim would not be sustained. Such a case was settled by the New York Court of Appeals, which decided that "earth excavation" included hard pan. A similar case arose in which an unfortunate contractor, who, having failed to examine the nature of the soil carefully, agreed to excavate and back fill a ditch at what would have been a very low figure even for earth. The contractor subsequently found that considerable of the excavation was in hard pan, and in some places rock. He commenced suit for the extra cost of the excavation, but the court would not admit evidence to prove the additional cost of the excavation, and said "it was the duty of the contractor to have ascertained the nature of the soil before entering into the contract; ordinary intelligence would have enabled him to do so."

**60. Using Sand From Premises.**—Sometimes a stipulation in the contract provides that "sand taken from the premises shall be used in the masonry." A New York court decided in a case of this kind, where the work was found defective on completion, due to the unsuitableness of the sand used, that the owner had no redress, though there was nothing in the report of the court to determine whether or not the contractor had notified the owner while the work was under way that the sand was not suitable. A good policy on the part of a contractor, however, would be to notify the owner in a similar case.

**61. Quality of Materials.**—It is not unusual to find in contracts that the quality of many of the materials to be used is not specifically stated. A New York court has decided that it is implied that they shall be of fair quality, or at least that they shall be sufficient and adequate. The decision of the court, as published in a law journal, is as follows:

"In every contract for the furnishing of the materials, and the performance of the work, in the absence of special provisions, there is an implied agreement on the part of the party who is to perform the work, and furnish the materials, that they shall not be of an insufficient and inferior description and value, and that the work shall not be totally inadequate to answer the purpose for which it was undertaken to be performed; and, though the agreement was that a specific sum should be paid for the work and materials, the claim may be reduced by showing that the work and materials were of an insufficient description and value, or it may be wholly defeated by showing that they were totally inadequate to answer the purpose for which they were to be furnished."

In regard to the stipulations in a Colorado specification that the "best lumber" should be used in a building, the Supreme Court decided that it meant the best that was ordinarily used in constructing buildings in that locality.

**62. Old Materials.**—A New York court, in regard to the ownership of old materials, said: "If the owner of land covered by houses, enters into a contract for the erection of other buildings on the same land, and does not provide for the use of the materials of the old building in the new, or does not remove them before the contractor takes possession under his contract, he will waive the right to them, and they will belong to the contractor."

**63. Estimating Quantities.**—The architect sometimes, though it is not usual for him to do so, prepares a bill of quantities of the material and labor that will be required in the construction of a proposed work. The contractor, however, should look with caution on such an estimate, even though the architect should assent to its correctness, and should verify for himself any such bill of quantities, unless, of course, the contract is simply for the execution of such a bill of material, instead of the erection of the building complete; for should the contractor base his agreement on this bill of quantities and afterwards find that the actual amount of material and labor required exceeded

the estimate, he would very likely find that nothing could be recovered through the courts.

Even in England, where the profession of "quantity surveying" is practised to a considerable extent and independent of the architect, the courts have held time and time again that no such estimate of the work was a guarantee, and that neither the quantity surveyor, architect, nor owner was responsible for its correctness. Hence, it would seem that there is no necessity for the architect to prepare any such bill of material, as the courts seem to be of the opinion that builders as a rule understand their business and are capable of making their own estimates, and should be responsible for them, provided the extent of the work is clearly stated to them by the architect or the owner through the plans and specifications prepared for the building.

## RESPONSIBILITY AND RISK

### BUILDER'S RESPONSIBILITY

**64. Safety of Building During Construction.**—The responsibility for the safety of a building during its construction usually devolves on the contractor, as has been decided in numerous cases. In a case where a contractor had entered into an agreement to raise a house and build under it another story, the building, while the work was progressing, fell and injured the adjoining property. The owner of the adjoining house entered suit for damages against the owner of the house undergoing alterations, but was defeated. The court held that the contractor was alone responsible, and said: "The distinction on which all such cases turn is this: If the person employed to do the work carries on an independent employment, and acts in pursuance of a contract with his employer, by which he has agreed to do the work on certain specified terms, in a particular manner, and for a specified price, then the employer is not liable. The power of directing and controlling the work is parted with by the

employer, and is given to the contractor." There are exceptions to this rule, however, where the courts have placed the blame on the owner; such a case was decided by the Supreme Court of Massachusetts. It seems, in this particular case, that a mason contracted to build a party wall. At the time the work was done there was freezing weather, and when the wall had progressed as high as the fourth story and the floorbeams were in place, the weather moderated, causing the mortar to thaw. The wall, thus softened, fell and damaged an adjacent building. In the suit that followed, the owner of the wall claimed that the contractors were alone responsible. Evidence was introduced tending to prove that the wall had not been properly braced, although it had been accepted by the architect as far as it had progressed, and also that the strength of the wall had been impaired by flues that were built in at the request of the owner of the adjoining property. The court, however, refuted the claim of the owner, that the contractor was alone responsible, by saying: "The general rule of law is that the person who, for his own purposes, brings on his land, and collects and keeps there, anything likely to do mischief if it escapes, must keep it at his peril; and if he does not do so is prima facie,* answerable for all the damage which is the natural consequence of its escape. This rule has been applied to dangerous animals, cesspools, to reservoirs, and to accumulations of snow and ice upon a building, by reason of the form of its roof."

Courts have generally held that where the fault or injury was due to the negligence of a subcontractor, the principal contractor was responsible.

If the contract provides that the building is to be erected according to certain plans and specifications, and the contractor agrees to such a stipulation, with the result that the building, when erected, is faulty and unsafe, courts have

* In law, a prima-facie case is one that is established by sufficient evidence, and can be overthrown only by rebutting evidence adduced by the other side—a case consisting of evidence sufficient to go to the jury; that is to say, one that raises a presumption of fact, and hence will justify a verdict, though it may not require one.

decided that the contractor cannot be held responsible if he has fulfilled the contract and carefully carried out the drawings and specifications. On the other hand, should he change the construction or deviate from the drawings or specifications, he is held responsible for the safety of the building.

**65. Insurance.**—The average contractor is called on to run numerous risks from fire, etc., which, if realized, would more than likely bankrupt him beyond any possibility of recovery. If the building should burn down or be subjected to destruction by any other unforeseen agency during the progress of construction, it is generally held that the contractor is responsible, and is bound by the stipulations in the contract, though the contract sometimes provides that should the contractor be delayed by such agencies as fire, water, cyclones, etc., an extension of time will be granted.

Hence, the duty of the builder, toward both himself and the owner, is to guard against such contingencies by taking out the proper insurance on the building. The Uniform Contract requires that the owner shall maintain the insurance necessary to cover the work and material incorporated in the building, and material upon the ground. The law is quite strict with contractors that have been so unfortunate as to have the building destroyed for which they contracted, and usually holds that they must finish the building according to the terms of the contract, no matter how severe it may be on them. When a building has been destroyed by some unforeseen agency, the courts have sometimes held that the builder was released from his contract by the "act of God," that is, by some power beyond human control. Such a case occurred in Connecticut, where a contractor had agreed to build a schoolhouse; it was nearly completed and $1,000 had been paid on account when it was struck by lightning and burned. The committee with which the contract had been made asked the contractor to commence rebuilding, and offered to extend the time of completing, which was nearly up when the fire occurred. The contractor, however, refused, saying that he had been released from the contract by an act

of God. The decision of the Supreme Court was against this, however, and held that he was not released.

**66. Responsibility for Accidents.**—The following rule of the Supreme Court of Illinois in a similar case, where the building under erection was blown down once and fell down the second time, caused, according to the contractors, by unforeseen defects in the soil, is interesting and explains itself: "If a party enters into an absolute contract, without any qualifications or exceptions, and receives from the party with whom he contracts the consideration of such an engagement, he must abide by the contract, and either do the act, or pay the damages; his liability arises from his own direct and positive undertaking. * * * If the covenant be within the range of possibility, however absurd or improbable the idea of execution may be, it will be upheld; as where one covenants it shall rain tomorrow. * * *. To bring the case within the rule of dispensation, it must appear that the thing to be done cannot by any means be accomplished; for, if it be only improbable, or out of the power of the obligor, it is not deemed in law impossible. * * * No matter how harsh and apparently unjust in its operation the rule may occasionally be, it cannot be denied that it has its foundation in good sense and inflexible honesty. He who agrees to do an act should do it unless absolutely impossible. He should provide against contingencies in his contract. Where one of two innocent persons must sustain a loss, the law casts it on him who has agreed to sustain it, or rather, the law leaves it where the agreement of the parties has put it." The court further said, in reciting the case, "If a party for a sufficient consideration agrees to erect and complete a building on a particular spot, and to find all the materials and do all the labor, he must erect and complete it, because he has agreed to do so. No matter what the expense, he must provide such a substructure as will sustain the building on the spot, until it is completed, and delivered to the owner. * * * If the difficulties are apparent on the surface, he must overcome them. If they are not, but become apparent by excavation,

or the shrinking of the building, the rule is the same. * * * The cases make no distinction between accidents that could be foreseen when the contract was entered into, and those that could not have been foreseen; between accident by the fault of the contractor, and those where he is without fault; they all rest on the simple principle. Such is the agreement, clear and unqualified, and it must be performed, no matter what the cost, if performance be not absolutely impossible. * * * The whole defense was properly overruled, because it did not show the performance of the contract impossible, or any lawful excuse for non-performance of the contract."

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### ARCHITECT'S AND OWNER'S RESPONSIBILITY

**67. Suits for Liability.**—In the American Institute of Architects' and the National Association of Builders' official form of contract, given in full at the end of this Section, there will be noticed in Art. I a stipulation that the architect is "acting for the purpose of this contract as agent of the said owner." In case of suit for liability that might be entered against the owner by persons injured while working on the building, this clause is likely (and especially so under the laws of some states) to cause trouble; for a shrewd lawyer might trace every occurrence about a building as emanating directly through the orders of the architect, who, acting as agent, makes the owner responsible for such occurrences; and hence the particular one that led to the injury of the plaintiff.

Such a calamity may be guarded against by some such clause as is given in the first form of contract hereinafter referred to. This clause places the responsibility for liabilities on the contractor, and reads as follows: "The contractor shall furnish all transportation, scaffolding, apparatus, ways, works, machinery, and plant requisite for the execution of this contract, and shall be solely answerable for the safe, proper, and lawful construction, maintenance, and use of the same; he shall cover and protect his work from damages, and all injury of the same, before the completion of

this contract, shall be made good by him; and shall be solely answerable for all damage or delay to the owner or his property, to other contractors or other employes of the owner, to neighboring premises, or to any person or property, due to the improper, illegal, or negligent conduct of the contractor, or of his subcontractors, employes, or agents, in or about the said building or the execution of the work covered by this contract or any extra work undertaken as herinafter provided."

The architect is thus relieved of his position as agent in all cases that might place the responsibility for liabilities on his client by that portion of the clause in the same contract which reads: "Neither the architect nor any person employed by him shall have any control or direction over the progress of the work, excepting the power of rejecting it, nor any control or superintendence over the scaffolding, apparatus, ways, works, machinery, or plant, the sole responsibility for which shall rest with the contractor; and further, the architect shall not be deemed the agent of the owner for any purpose whatsoever, except as the owner may in fact give him a special and express authority."

Since most first-class builders have their liabilities insured, they would have no incentive to throw such responsibilities on the owner; but in order that the owner may be secure against any legal action by injured employes, the best plan would be to insert such clauses as are just given.

**68. Architect's Responsibility for Work Not Conforming to the Specifications.**—There is considerable difference of opinion shown in the decisions of the courts as to the legal responsibility of the architect for work that is not according to the drawings and the specifications. The consensus of opinion seems to be in favor of holding the contractor responsible for exactly complying with the drawings and specifications, and that the architect be held responsible for a reasonable degree of professional knowledge and skill, and that he devote a greater amount of care and attention to his employer's affairs than to smiliar work of his own.

The following decision by a New York chief justice, in an important case, states clearly what seems a very fair conception of the duties of the architect as the agent of the owner and his responsibility for work not executed according to the drawings and specifications: "The counsel would not contend that the architect is an insurer of the perfection of the masonwork, the carpenter work, the plumbing, etc. He is bound only to exercise reasonable care and to use reasonable powers of observation and detection in the supervision of the structure. * * * An architect is no more a mere overseer, or foreman, or watchman, than he is a guarantor of a flawless building; and the only question that can arise in a case where general performance of duty is shown, is whether, considering all the circumstances and peculiar facts involved, he has or has not been guilty of negligence. This is a question of fact, and not of law."

**69. Architect's Responsibility for Defective Drawings or Specifications.**—Where the architect has shown beams or columns on his drawings that are too weak to carry the loads placed on them, and the building tumbles down as a result, he would probably be held legally responsible. The weight of legal opinion seems to be in favor of making him liable for the consequences of what can be proved to be lack of ordinary professional skill and care in preparing the plans and specifications.

**70. Importance of Insuring.**—Where the rules of the insurance companies permit, the owner should insure his own and also the risks of all the contractors engaged on the work, which, in case of loss by fire, will be paid according to the particular interests of the parties engaged. See Art. XI, Form 3. Should the laws of the insurance companies not allow them to issue a policy in the names of more than one person, the builder should be required to insure to the full amount of his interest; and, since they are likely to neglect doing so for the sake of the financial saving, the architect should demand this policy and see that it is all that is required, retaining it in his hands for safe keeping.

The importance of a stipulation to this effect is evident; for if the builder should neglect to insure, and if the partly erected building should burn down, he would, in many cases, be thrown into bankruptcy and the owner would be compelled to finish the contract with the assignee or some other contractor.

**71. Mechanic's Lien.**—A **mechanic's lien** is a lien on real property, given by statutes in most of the United States, to mechanics and material men, for the price and value of improvements supplied by them. With reference to buildings, it is a lien given to mechanics and material men as security for their claims for work done or materials furnished, for and about the erection or alteration of the buildings.

A mechanic or a material man has no right to retain possession of a building until his debt is paid; he has a mere right to sue out and enforce his lien, and thus charge the property with the payment of his particular debt in preference to other debts, so far as the statute confers such preference, if all the requisites of the statute have been observed.

There can be no mechanic's lien unless the work done or materials furnished were done or furnished under or by virtue of a contract with the owner of the property, or some agent duly appointed by him. The contract need not be in writing, except when required by statute, and it need not contain any express stipulation for a lien, as the lien is given by statute independent of the terms of a contract. If the material man sells his materials with no understanding as to the purpose to which they are to be put, he can assert no lien on the building in which they are placed. It is only when the materials are furnished for a purpose mentioned in the statute that a lien is acquired.

The statutes of most states require that a notice be given of the lien, and docketed among the proper public records so as to give notice to the world of its existence.

In the majority of the states, the lien begins from the date of commencement of the building; in some states, the lien

commences when the labor or material is furnished to the building.

The duration of a mechanic's lien is, in all states, a matter of statutory regulation. In some states, the lien continues until the expiration of a definite period, usually 6 months, from the performance of the work, or the furnishings of the materials. If a formal claim is filed before the expiration of this period, the lien is continued for a period varying from 2 to 5 years.

In some states, the architect that draws the plans and superintends the construction of a building has a valid lien for his services. In other states, distinction is made between an architect that draws plans for a building only and one that superintends its erection, the latter being held to be entitled to a lien, but in some states no architect is entitled to a lien.

The mode for enforcing the lien is usually a matter of statutory provision. In some states this is done by a foreclosure of a mortgage, others require the filing of a bill in chancery, while other states authorize the issuance of an attachment. Whatever may be the proceeding prescribed, the person whose property is sought to be charged with the lien is given the opportunity to interpose any defense he may have.

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### LEGAL MEANING OF WORDS

**72. "Commencement" and "Erection."**—A question sometimes arises as to when a building is properly *commenced;* whether it is when the batter boards are set, when the excavation is started, or when the first footing stone is laid. The New Jersey Supreme Court held the opinion in two cases that a building was commenced when the excavation was begun.

The direct meaning of the word *erection* is somewhat obscure, and while it is a word much used in contracts and specifications, there seems to be a great difference of opinion in regard to what may be inferred by the phrase *upon the erection of.* Some hold that it means the completion of the building or structure; others claim that something else is

meant. A case in Illinois called for a decision from the Supreme Court as to when a building should be considered as being erected. The court decided that the building in question be considered as erected, although it had no roof on and not one gable or chimney was built; the flooring had not been laid, but the materials for the roof, floor, and windows had been delivered on the ground. In Indiana, the court held that a house had been erected wherein the plastering had not yet been done and some of the windows had not been placed; and most of the states in which such cases have arisen have held the opinion that a building was erected where the walls were up and the materials with which to complete it were on the site.

**73. "As Directed."**—The expression *as directed*, as pertaining to its use in specifications in connection with the manner in which work shall be done, was passed on by the Supreme Court of Missouri during a controversy as to whose directions were meant, and was held to imply those of the owner. All controversy on this score can be avoided by stating whose direction is intended, the owner's or the architect's.

**74. "Not Less."**—The phrase *not less*, which is much used in specifications, hence forming a term in the agreement, seems to be rather unnecessary in most cases, and is liable to cause trouble. It is principally used in making some such stipulation as this: "The cellar shall be excavated to a depth of not less than 10 feet." A stipulation like this was made in a contract for the erection of a building in the state of New York. After the contractor had excavated to the required depth, the nature of the soil demanded further excavation in the footing trenches, and in consequence the cellar wall had to be extended. In the suit brought by the contractor to recover the cost of the extra work, the Supreme Court decided that it was due him. In all cases of this kind, the court will carefully consider the meaning of the contract to determine whether the contractor really intended to bind himself to do the work beyond the given

dimensions should the architect, in the execution of the work, deem it advisable, owing to conditions unforeseen.

**75. "More or Less."**—A contract will sometimes stipulate that a certain amount of material *more or less* shall be furnished. A New York court held that the term as used implied the delivery and acceptance of just the actual amount of material required for the work, and that the term as used did not mean any definite quantity.

**76. Other Phrases.**—In most formal contracts, it is usual to refer to the specifications that constitute part of the agreement as the *specifications hereto annexed.* The courts hold that it is not necessary that the specifications should be actually attached to the formal contract; for so long as the particular specification referred to in the contract can be proved as the one meant, that is all that is legally required. Also, if the phrase, *the specifications signed herewith*, is used in the formal contract, it is not actually required that they should be signed, provided the ones intended in the formal contract can be identified without such signatures. It undoubtedly would be advisable, however, to sign all specifications, and even plans, so that there may be no controversy in regard to the ones designated in the formal contract.

## FORMS OF CONTRACT

**77. Specimen Contracts.**—The preceding pages have been devoted to points of law likely to be raised in respect to contracts, the study of which will enable one, when called on to become a party to a contract, to do so intelligently.

The two forms of contract that are now given in full are representative and legally correct. The first form is very complete, provisions being made in it to cover every contingency that is likely to arise in an important building operation, and which long experience in building transactions has demonstrated should be guarded against. The second form is more brief, and not so complete in the extent of the ground covered, but is the one that is generally used.

This contract is the official contract of the American Institute of Architects and National Association of Builders, and is known as "The Uniform Contract." It is used in the printed form, which is obtainable at nearly all stationery-supply stores. It has been carefully compiled by a joint committee of the Institute and Association, and is subject to such change and modification each year as may be deemed necessary to make it more complete or binding.

**78. Building Contract.**—The text of the ordinary building contract herein first referred to follows:

BUILDING CONTRACT

between_____of_____
hereinafter called the Owner, and _____
of_____hereinafter called the Contractor, made
at_____the_____day of_____19____

The respective parties hereto, each in consideration of the agreements of the other herein set forth, agree each with the other as follows:

THE CONTRACTOR'S AGREEMENT

The Contractor, his heirs or assigns, agrees to_____

_____

according to certain plans and specifications prepared by_____

_____of _____Architect. Said plans and specifications, together with this contract, of which they are to be deemed a part, are to be construed together, so that any work shown on the plans, though not mentioned in the specifications, or vice versa, or any provision of the contract not repeated in the plans or specifications, or vice versa, is to be executed by the Contractor as a part of this contract. Figured dimensions are to prevail over scale measurements. All things which in the opinion of the Architect may fairly be inferred from the plans and specifications, are to be executed by the Contractor as a part of this contract. If complete drawings of details have not yet been made, the same, when made and conforming to said plans and specifications, are to constitute a part of this contract, the Architect being the sole judge as to whether said detailed drawings conform to said plans and specifications. All the plans and drawings received by the Contractor at any time during the continuance of this contract are at its termination to be returned to the Architect.

All material and work, where the quantity, dimensions, and quality are not shown on the plans or specified in the specifications, are to be furnished in sufficient quantity and of sufficient dimensions for the proper execution of the work as determined by the Architect, and the

quality and workmanship are to be the best throughout and satisfactory to the Architect.

The Contractor is to take out at his own expense all necessary permits from the municipal or other public authorities, to give all the notices required by law or municipal ordinance, and to pay all fees and charges incident to the due and lawful prosecution of the work covered by this contract.

If this contract involves excavation or masonwork, the Contractor is to execute the same without encroaching upon adjoining public or private property, and shall procure for the Owner the certificate of some competent surveyor, to be selected by the Owner, that there has been no such encroachment; unless the plans themselves provide for such encroachment, in which case the Contractor shall be relieved from all responsibility as to the correct location of the walls and foundations in this respect.

The Contractor shall devote his time and personal superintendence to the execution of this contract, and shall employ a competent foreman, who shall at all times be present while any work is being done under this contract at the building.

The entire work and all its parts, including material, workmanship, and rate of progress, shall be satisfactory to the Architect. All materials rejected by the Architect, whether worked or unworked, and whether affixed to the building or not, shall be removed from the premises (and for that purpose taken down if already attached to the building) at the request of the Architect; and all work condemned by the Architect, as in any way unsound or as not conforming to the terms of this contract, shall be taken down forthwith and rebuilt by the Contractor in accordance with the contract and in a manner satisfactory to the Architect. The Contractor shall dismiss any of his employes if the Architect considers said employes incompetent or careless and so informs the Contractor.

The Contractor shall clear away all dirt and rubbish caused by his operations as often as requested by the Architect or Owner, and shall leave the premises at the termination of this contract free from such dirt and rubbish and in a neat and clean condition.

The Contractor shall prosecute the work speedily and continuously

_____

_____

and the entire work covered by this contract shall be finished by the _____ day of _____ 19____ The damages for default are fixed at _____ dollars for every day thereafter that the said work shall remain unfinished.

The Contractor shall make good all defects, omissions, and violations of the terms of this contract whensoever discovered, during the progress of the work or afterwards, notwithstanding any payments

that may have been made, or any certificates that may have been given, or any possession or acceptance of the work by the Owner, and shall be responsible for any damages that may be caused in making good said defects, omissions, or violations.

The Contractor shall comply with all the laws, ordinances, and regulations for the time being in force in the city or town where the building is situated and relating to the building or other work included in this contract, and shall satisfy all the requirements of the Inspectors (if there be such).

The Contractor shall furnish all transportation, scaffolding, apparatus, ways, works, machinery, and plant requisite for the execution of this contract, and shall be solely answerable for the safe, proper, and lawful construction, maintenance, and use of the same; he shall cover and protect his work from damage, and all injury to the same, before the completion of this contract, shall be made good by him; and shall be solely answerable for all damage or delay to the Owner or his property, to other Contractors or employes of the Owner, to neighboring premises, or to any person or property, due to the improper, illegal, or negligent conduct of the Contractor, or of his subcontractors, employes, or agents, in or about the said building or the execution of the work covered by this contract or any extra work undertaken as hereinafter provided.

The Contractor shall have sole charge and possession of the work covered by this contract until the termination thereof; but shall permit the Owner and the Architect and any person employed by either of them to visit, enter, and inspect the said work at all times and places during the progress thereof, and shall provide safe and proper facilities for such inspection.

The Contractor shall permit other contractors or employes of the Owner to prosecute their work, and shall render them all necessary assistance.

### THE OWNER'S AGREEMENT

The Owner, his heirs, or assigns agree to pay the Contractor in monthly sums amounting to 90 per cent. of the value of the work done during the previous month. These payments shall be made upon the presentation of certificates from the Architect; provided, however, that none of the foregoing payments shall be due or payable unless the Contractor shall deliver to the Owner the written certificate of some competent surveyor, to be selected by the Owner, that there has been no encroachment upon adjoining public or private property and unless the property is free from all lien for debts due, or claimed to be due, the Contractor, and satisfactory evidence thereof furnished (if requested) to the Owner by the Contractor; also with the understanding that making of any of these payments does not imply the acceptance of any work not in accordance with the drawings and specifications.

### ALTERATIONS AND EXTRAS

The Architect may, in writing, and from time to time, order the Contractor to make any changes in the work which do not increase the cost to the Owner or affect the time of completion. In case said changes make the work less expensive to the Contractor, a proportional deduction shall be made from the contract price above specified. In no case shall any change be made in the work which shall increase the cost of the work to the Owner, or involve any extension of time, without his express and special consent; and, if the Contractor shall proceed to execute such change without first obtaining such consent, he shall be concluded against making an extra charge for the said change or any claim for further time.

In case of any change ordered by the Architect as aforesaid, or in case any other changes in the work are made by the mutual consent of the parties hereto, whether affecting the contract price or not, or the time of completion or not, all and singular the other provisions of this contract shall remain in force, and apply to the contract as thus altered.

### ORDERS FOR PAYMENTS

If any orders are accepted by the Owner (and it is understood that he shall be under no obligation to accept any), such acceptances shall be conditional on the due performance by the Contractor of all and singular the provisions of this contract, and subject to alterations as aforesaid.

### THE ARCHITECT

The Architect mentioned in this contract is understood to be _____ _____ of _____ or such other Architect as the Owner may hereafter select; any change to be notified to the Contractor in writing.

The Architect shall have authority to enter and inspect the work at all times, to reject all material (whether set up or not) and to condemn all work which in his opinion is not in conformity with the provisions of this contract, and to do all the things hereinbefore set forth as within his powers. Neither the Architect nor any person employed by him shall have any control or direction over the progress of the work, excepting the power of rejecting it, nor any control or superintendence over the scaffolding, apparatus, ways, works, machinery, or plant, the sole responsibility for which shall rest with the Contractor; and neither of them shall have power to order extras or alterations, except as above provided, or any authority other than that expressly set forth in this contract. The Architect shall not be deemed the agent of the Owner for any purpose whatsoever, except as the Owner may in fact give him a special and express authority.

### MISCELLANEOUS PROVISIONS

No payment of money under this contract, nor any acceptance or possession taken of the work done by the Contractor, nor any certificate given, shall be evidence of the performance of this contract or be construed as a waiver of any of its provisions by the Owner; nor shall any waiver of any breach of this contract be held to be a waiver of any other or subsequent breach.

If, in the opinion of the Architect, the Contractor is obstructed or delayed in the prosecution or completion of the work by the neglect, delay, or default of any other contractor, or by any damage which may happen thereto by fire, or by the unusual action of the elements, or by the abandonment of the work by the employes in a general strike, then the Contractor shall be entitled to such extension of the time specified above for the completion of the work as the Architect shall in writing certify; provided, however, that claim is made by the Contractor at the time and in writing.

If at any time before the completion of this contract the Contractor becomes bankrupt or insolvent, or makes an assignment for the benefit of creditors, or assigns this contract or sublets any part of it without the consent of the Owner first obtained in writing, or becomes incapable of completing the contract, or shall at any time for six days refuse or neglect to proceed with the contract work in the manner herein agreed to the satisfaction of the Architect, then the owner may at once terminate this contract by a written notice delivered to the Contractor in person or at his usual place of business, and proceed to complete the work with other mechanics or contractors, and account to the Contractor or his legal representatives as follows: The Owner shall be credited with all payments theretofore made by him to the Contractor, with the entire cost of completing the work with said other mechanics and contractors, and with all damages by delay or otherwise, caused by the default of the Contractor, including reasonable expenses of counsel. If the contract price exceeds the total amount of these credits, the excess shall be paid to the Contractor or his legal representatives. In case orders accepted by the Owner are outstanding, the holders thereof shall be entitled to such excess in preference to the Contractor or his legal representatives. If, however, the total amount of the said credits exceeds the contract price, the excess shall be due from the Contractor to the Owner. In such accounting, the Owner shall not be held to obtain the lowest figure for the work of completing the contract; but all sums actually paid by him for such completion shall be credited to him.

All material delivered at the building by or on account of the Contractor, and intended to be incorporated with the building, shall become the property of the Owner as delivered; but the Contractor

may repossess himself of any surplus left at the completion of the contract. All scaffolding, apparatus, ways, works, machinery, and plant brought upon the premises by the Contractor, or used by him, shall remain his property, but in case of default and a completion of the contract work by the Owner, the latter shall be entitled to use the said scaffolding, apparatus, ways, works, machinery, and plant without cost or liability for depreciation or injury by use.

If the Owner does not make the payments herein provided as and when the same shall become due and payable he shall be liable to the Contractor for interest on the same; and if such default continues for a period of ten days, the Contractor may, by a written notice delivered to the Owner in person or at his usual place of business, terminate this contract. But the acceptance of any money under this contract subsequent to such defaults shall operate as a waiver thereof and of the right to terminate this contract by reason thereof.

The Owner shall keep the building and the material on the premises insured against fire in such companies as he shall select, for the benefit of himself or any mortgagee and of any and all contractors on the building who shall request such insurance in writing. The expense of said insurance shall be borne by the Owner; but he shall not be responsible for carrying too little insurance, unless the Contractor has requested him in writing to insure in a certain specified amount, and the Owner has neglected to do so for an unreasonable length of time. In the event of a fire, the insurance shall be divided between the Owner and any mortgagee and those contractors for whose benefit the insurance was taken out, as their interests may appear; and the parties hereto shall respectively proceed to the completion of this contract.

All disputes arising out of this contract or the performance or breach thereof shall be settled by mutual agreement or in a court of law or equity before a single justice, auditor, or special master, and no claim shall be made for a trial by jury on the whole case or special issues.

In witness whereof, we, the said_____
and the said_____
hereto set our hands and seals this_____day of_____19___

**79. Uniform Contract.**—The so-called "Uniform Contract" adopted by the American Institute of Architects and the National Association of Builders is a printed instrument with spaces left for filling in the specific details peculiar to each case, as shown in Form 1. The lines left blank for the names of the contractor and owner are ample for the name and address of either party when it consists of a firm

or long-titled corporation. The lines near the bottom of Form 1 are for a list of the work included by the contract for the building to be erected, together with its location.

Form 2 is printed on the second page of the "Uniform Contract" and continues the terms of the agreement down to Art. VIII. In Art. VI, five lines are left for the dates at which various portions of the building shall be completed; and six additional lines are left blank to insert provisions for contingencies of delay, such as strikes, interference of other contractor, severe weather, etc.

Form 3 constitutes the third page of the "Uniform Contract" and contains, in Art. IX, space for the gross amount of the contract to be written in; under which are provided blank lines whereon to state the number, amount, and time of payment of each instalment of the contract price. Art. XI provides the insurance clause and leaves spaces for special conditions of insurance if such are required. Then follows the space for the signatures of the contracting parties, while under the words "In presence of" is placed the signature of a witness, who is usually, though not necessarily, the architect.

The contract is folded twice, after it has been signed, and on the outside of the fourth page is a blank form that, when filled out, gives information regarding the document, as shown in Form 4. This is not necessarily a part of the document, but it is simply an indorsement or title by which the contract may be recognized without unfolding it.

# THE UNIFORM CONTRACT

FORM OF CONTRACT
ADOPTED AND RECOMMENDED FOR GENERAL USE BY THE
AMERICAN INSTITUTE OF ARCHITECTS
AND THE
NATIONAL ASSOCIATION OF BUILDERS

_____
ARCHITECTS

**This Agreement,** made the _____ day of _____ in the year one thousand nine hundred and _____ by and between _____

_____

_____party of the first part (hereinafter designated the Contractor), and _____

_____party of the second part (hereinafter designated the owner),

**Witnesseth** that the Contractor, in consideration of the fulfillment of the agreements herein made by the Owner, agrees with the said Owner, as follows:

ARTICLE I. The Contractor under the direction and to the satisfaction of _____ Architects, acting for the purposes of this contract as agents of the said Owner, shall and will provide all the materials and perform all the work mentioned in the specifications and shown on the drawings prepared by the said Architects for the _____

_____

which drawings and specifications are identified by the signatures of the parties hereto.

ART. II. The Architects shall furnish to the Contractor, such further drawings or explanations as may be necessary to detail and illustrate the work to be done, and the Contractor shall conform to the same as part of this contract so far as they may be consistent with the original drawings and specifications referred to and identified, as provided in Art. 1.

It is mutually understood and agreed that all drawings and specifications are and remain the property of the Architects.

ART. III. No alterations shall be made in the work shown or described by the drawings and specifications, except upon a written order of the Architects, and when so made, the value of the work added or omitted shall be computed by the Architects, and the amount so ascertained shall be added to or deducted from the contract price. In the case of dissent from such award by either party hereto, the valuation of the work added or omitted shall be referred to three (3) disinterested arbitrators, one to be appointed by each of the parties to this contract, and the third by the two thus chosen; the decision of any two of whom shall be final and binding, and each of the parties hereto shall pay one-half of the expenses of such reference.

ART. IV. The Contractor shall provide sufficient, safe and proper facilities at all times for the inspection of the work by the Architects or their authorized representatives. He shall, within twenty-four hours after receiving written notice from the Architects to that effect, proceed to remove from the grounds or building all materials condemned by them, whether worked or unworked, and to take down all portions of the work which the Architects shall by like written notice condemn as unsound or improper, or as in any way failing to conform to the drawings and specifications.

ART. V. Should the Contractor at any time refuse or neglect to supply a sufficiency of properly skilled workmen, or of materials of the proper quality, or fail in any respect to prosecute the work with promptness and diligence, or fail in the performance of any of the agreements herein contained, such refusal, neglect or failure being certified by the Architects, the Owner shall be at liberty, after _____ days written notice to the Contractor, to provide any such labor or materials, and to deduct the cost thereof from any money then due or thereafer to become due to the Contractor under this contract; and if the Architects shall certify that such refusal, neglect or failure is sufficient ground for such action, the Owner shall also be at liberty to terminate the employment of the Contractor for the said work and to enter upon the premises and take possession, for the purpose of completing the work comprehended under this contract, of all materials, tools and appliances thereon, and to employ any other person or persons to finish the work and to provide the materials therefor; and in case of such discontinuance of the employment of the Contractor he shall not be entitled to receive any further payment under this contract until the said work shall be wholly finished, at which time, if the unpaid balance of the amount to be paid under this contract shall exceed the expense incurred by the Owner in finishing the work, such excess shall be paid by the owner to the Contractor, but if such expense shall exceed such unpaid balance, the Contractor shall pay the difference to the Owner. The expense incurred by the Owner as herein provided, either for furnishing materials or for finishing the work, and any damage incurred through such default, shall be audited and certified by the Architects, whose certificate thereof shall be conclusive upon the parties.

ART. VI. The Contractor shall complete the several portions, and the whole of the work comprehended in this Agreement by and at the time or times hereinafter stated _____

_____

_____

_____

_____

_____

provided that _____

_____

_____

_____

_____

_____

ART. VII. Should the Contractor be obstructed or delayed in the prosecution or completion of his work by the act, neglect, delay or default of the Owner, or the Architects, or of any other contractor employed by the Owner upon the work, or by any damage which may happen by fire, lightning, earthquake or cyclone, or by the abandonment of the work by the employees through no default of the Contractor, then the time herein fixed for the completion of the work shall be extended for a period equivalent to the time lost by reason of any or all the causes aforesaid; but no such allowance shall be made unless a claim therefor is presented in writing to the Architects within twenty-four hours of the occurrence of such delay. The duration of such extension shall be certified to by the Architects, but appeal from their decision may be made to arbitration, as provided in Art. III of this contract.

ART. VIII. The Owner agrees to provide all labor and materials not included in this contract in such manner as not to delay the material progress of the work, and in the event of failure so to do, thereby causing loss to the Contractor, agrees that he will reimburse the Contractor for such loss; and the Contractor agrees that if he shall delay the material progress of the work so as to cause any damage for which the Owner shall become liable (as above stated), then he shall make good to the Owner any such damage. The amount of such loss or damage to either party hereto shall, in every case, be fixed and determined by the Architects or by arbitration, as provided in Art. III of this contract.

ART. IX. It is hereby mutually agreed between the parties hereto that the sum to be paid by the Owner to the Contractor for said work and materials shall be $ _____

_____

_____

_____

_____

subject to additions and deductions as hereinbefore provided, and that such sum shall be paid in current funds by the Owner to the Contractor in installments as follows:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

The final payment shall be made within _____ days after this contract is fulfilled.

All payments shall be made upon written certificates of the Architects to the effect that such payments have become due.

If at any time there shall be evidence of any lien or claim for which, if established, the Owner or the said premises might become liable, and which is chargable to the Contractor, the Owner shall have the right to retain out of any payment then due or thereafter to become due an amount sufficient to completely indemnify him against such lien or claim. Should there prove to be any such claim after all payments are made, the Contractor shall refund to the Owner all moneys that the latter may be compelled to pay in discharging any lien on said premises made obligatory in consequence of the Contractors default.

ART. X. It is further mutually agreed between the parties hereto that no certificate given or payment made under this contract, except the final certificate or final payment, shall be conclusive evidence of the performance of this contract, either wholly or in part, and that no payment shall be construed to be an acceptance of defective work or improper materials.

ART. XI. The Owner shall during the progress of the work maintain full insurance on said work, in his own name and in the name of the Contractor, against loss or damage by fire. The policies shall cover all work incorporated in the building, and all materials for the same in or about the premises, and shall be made payable to the parties hereto, as their interest may appear.

_____

_____

_____

_____

_____

_____

ART. XII. The said parties for themselves, their heirs, executors, administrators and assigns, do hereby agree to the full performance of the covenants herein contained.

**In Witness Whereof,** the parties to these presents have hereunto set their hands and seals, the day and year first above written.

*In presence of*

_____ SEAL

_____ SEAL

_____ SEAL

_____ SEAL

# THE UNIFORM CONTRACT

FORM OF CONTRACT

ADOPTED AND RECOMMENDED FOR GENERAL USE BY THE

AMERICAN INSTITUTE OF ARCHITECTS

AND THE

NATIONAL ASSOCIATION OF BUILDERS

# AGREEMENT

BETWEEN

_____

*Contractor*

AND

_____

*Owner*

FOR

_____

AT

_____

_____

DATED

_____ *190*__

ARCHITECTS,

_____

_____

AMOUNT OF CONTRACT,

$_____

FORM 4

### CONTRACTOR'S BOND

**80. Bonding of Contractor.**—In large and important work, the contractor is often required by the owner to furnish a bond to protect him (the owner) against the failure of the contractor to finish the work according to the contract. In case the contractor should become bankrupt before the completion of the work and be compelled to relinquish the contract, the person or corporation who had gone his surety would be compelled either to employ some other contractor to carry out the contract or to hand over to the owner the amount of the bond, which amount would be figured to be sufficient to enable the owner to employ another contractor to finish the building or work. Forms 5, 6, and 7 show the pages of an application blank for such a bond. This is filled out by the contractor or contracting company, as the case may be, and if all is satisfactory and proper, indemnity is offered by the contractor or the company that issues the bond. The bond is issued by the bonding company. A copy of such a document is shown in Forms 8, 9, and 10, and is filled out to show about what is required. Form 11 shows the title, which appears on the outside when the bond is folded.

It will be noticed that this blank is for an incorporated construction company, another bond blank similar in form being used where the principal is an individual.

CONTRACTOR'S APPLICATION
Form 721, 5m-1-29-06
Revised 7-07

SURETY DEPARTMENT
Contract Division

*Application No.* _____

*Bond No.* _____

*Form of Bond* _____

# The Colonial Title Guaranty Company

## of Boston, Penna.

Applicants must give full and explicit data under the following heads, and must supply copies of Specifications and Contract for filing with this application. When the contract involves construction, plans or drawings must accompany the application, and will be promptly returned after examination of same. As these requirements are essential to the proper preparation of the bond and the Company's judgment of the case, care in complying with requirements will expedite the issuance of the bond.

1 Full name of applicant _____
(individual, firm, or corporation)

2 Business address _____
(street, city, and state)

3 Residence _____
(street, city, and state)

4 Name and title of officers duly authorized to sign contracts and other sealed papers binding upon the company (if incorporate) _____

5 Amount of bond required, $ _____

6 To whom given? Give full name. If to a corporation, give exact corporate title and names of officers required to sign corporate instruments, also the business address of individual, firm, or corporation

7 Nature of contract _____

8 How long must work be kept in repair after completion? _____

9 Contract price _____

10 If contract price is per unit of measure, give also probable total of contract

Total of contract, $ _____

11 Applicants must, whenever possible, furnish names and addresses of other bidders, with amount of their respective bids.

| | (Name) | (Address) | (Bid) |
|---|---|---|---|
| (Highest) | | | |
| (Lowest) | | | |

12 Date work is to be commenced _____

13 Date work is to be completed _____

14 Penalty for non-completion at above date _____

15 Premium for completion before above date _____

16 Payments _____

17 Percentage reserved from payments until completion _____

18 Have you ever applied for a contract bond to this or any other company? Ans. _____

19 If so, state name of company, the date, and whether accepted or declined. Ans. _____

20 If declined, state reasons _____

21 Mention experience in line of work to be undertaken _____

22 Number of other contracts now on hand _____

23 Amount of each contract _____

24 When will they be completed? _____

25 Name of surety company which issued bond on above _____

26 **STATEMENT OF ASSETS AND LIABILITIES**

| | | | | | |
|---|---|---|---|---|---|
| Cash in bank | | | Borrowed or due on stocks, bonds, etc. | | |
| Stocks, bonds, etc., market value | | | Capital stock paid (if any) | | |
| Real estate (title in applicant's name) | | | Borrowed or due on real estate | | |
| Parcel No. 1 | | | Parcel No. 1 | | |
| " " 2 | | | " " 2 | | |
| " " 3 | | | " " 3 | | |
| " " 4 | | | " " 4 | | |
| Plant consisting of | | | Encumbrance on plant | | |
| | | | | | |
| | | | | | |
| | | | | | |
| Stock of supplies | | | | | |
| Notes receivable | | | Notes payable | | |
| Accounts receivable | | | Accounts payable | | |
| Other assets | | | Other liabilities | | |
| | | | | | |
| TOTAL ASSETS | | | TOTAL LIABILITIES | | |

27 Amount of liability as endorser or surety for others, $ _____

28 Amount of Employer's Liability Insurance carried (give names of companies). $ _____

29 If a firm, mention individual property holdings, real and personal, not included in above statement, and any encumbrance

30 What indemnity do you offer to induce the company to execute this bond? _____

31 **IF A COPARTNERSHIP ANSWER THESE QUESTIONS:**

Names of all individuals composing same. Please write names and addresses plainly.

| NAME | POST-OFFICE ADDRESS |
|---|---|
| | |
| | |
| | |
| | |
| Has any member of the firm ever failed in business? | |

82

## IF A CORPORATION ANSWER THESE QUESTIONS:

In what State incorporated _____ When incorporated _____

Principal office _____

Authorized capital _____ Subscribed capital _____ Paid-up capital _____

President _____ Vice-President _____

Secretary _____ Treasurer _____

## REFERENCES

| NAME | BUSINESS | POST-OFFICE ADDRESS |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

In consideration of THE COLONIAL TITLE GUARANTY COMPANY OF BOSTON, PENNA., becoming surety on the bond herein applied for, the undersigned _____ does hereby covenant and agree to pay in advance the premium or fees hereafter agreed upon, *namely*, $ _____ for *bid bond* (the same to be credited on the premium for the contract bond): _____ dollars for the first year thereof and _____ dollars annually thereafter until it shall serve upon said Company at its home office, in the city of Boston, Pennsylvania, competent written evidence of its discharge from such suretyship and all liability by reason thereof; and the undersigned does hereby bind itself, its heirs, executors, administrators, successors, and assigns to indemnify said THE COLONIAL TITLE GUARANTY COMPANY OF BOSTON, PENNA., against all loss, costs, damages, charges, and expenses, whatever, resulting from any of its acts, default, or neglect that said THE COLONIAL TITLE GUARANTY COMPANY OF BOSTON, PENNA., may sustain or incur by reason of its having executed said bond or any continuation thereof. And the undersigned does further agree, in the event of its being unable to complete or carry on the aforementioned contract, to assign, and does hereby assign such plant as the undersigned may own, or have upon said work to said THE COLONIAL TITLE GUARANTY COMPANY OF BOSTON, PENNA. The undersigned hereby further agrees, for itself, its successors, and assigns, to accept the vouchers or other evidence of any loss paid by said THE COLONIAL TITLE GUARANTY COMPANY OF BOSTON, PENNA., under the aforesaid obligation, together with vouchers or other evidence of payment, of all costs and expenses whatever incurred by said THE COLONIAL TITLE GUARANTY COMPANY OF BOSTON, PENNA., in adjusting such loss or in completing said contract, as conclusive evidence against it, its heirs, executors, administrators, successors, and assigns of the fact and extent of its liability under said obligation to said THE COLONIAL TITLE GUARANTY COMPANY OF BOSTON, PENNA.

And the undersigned does further agree in the event of any breach or default on its part in any of the provisions of the contract hereinbefore mentioned, that THE COLONIAL TITLE GUARANTY COMPANY OF BOSTON, PENNA., as surety upon the aforesaid bond shall be subrogated to all its rights and properties as principal in said contract, and that deferred payments and any and all moneys and properties that may be due and payable to it at the time of such default or that may thereafter become due and payable to it on account of said contract, shall be credited upon any claim that may be made upon THE COLONIAL TITLE GUARANTY COMPANY OF BOSTON, PENNA., under the bond above mentioned.

These covenants shall be binding not only upon the undersigned, jointly and severally, but as well upon the respective heirs, executors, administrators, successors, and assigns.

Dated at _____ this _____ day of _____ 19 ____

_____
*Applicant*

_____ By _____
*Witness*

_____
(*Title if applicant be a corporation*)

## STATEMENT OF AGENT

Personal knowledge of applicant, reputed ability and experience _____

Premium agreed upon _____

Impress upon the applicant the necessity of full and explicit answers to the various questions. At time of forwarding to home office, make note of features not covered by replies and supply the information asked for at as early a date as possible. *See that the application is properly signed and the signatures witnessed.* Secure copy of Contract and Specifications for file with this application. *Attention to these various features will insure prompt action.*

SURETY DEPARTMENT
Contract Division

BOND NO. 825

# The Colonial Title Guaranty Company

of Boston, Penna.

## Know all Men by these Presents:

That The Scranton Construction Company

a corporation organized under the laws of the Commonwealth of Pennsylvania (hereinafter called the Principal), and **The Colonial Title Guaranty Company, of Boston, Penna.**, a corporation created and existing under the laws of the Commonwealth of Pennsylvania, and whose principal office is located in the city of Boston, Commonwealth of Pennsylvania (hereinafter called the Surety), are held and firmly bound unto John Jones

(hereinafter called the Obligee), in the full and just sum of $10,000.00 Ten Thousand Dollars, lawful money of the United States, to the payment of which sum, well and truly to be made, the said Principal binds itself, its successors and assigns, and the said Surety binds itself, its successors and assigns jointly and severally, firmly by these presents.

Signed, sealed and delivered this 1st day of Jan. A. D. 190 6.

**Whereas**, said Principal has entered into a certain written contract with the Obligee, to perform the excavation, mason work, carpenter work, and painting necessary for the erection of a single dwelling house in the city of Boston upon lot at the northeast corner of A street and B avenue. All work to be according to drawings and specifications prepared by John A. Adams, Architect, which drawings and specifications are identified by the information given above and by the signatures of the principal and obligee attached thereto. The consideration in the written contract for this work being $20,000.00.

**Now, Therefore,** The condition of the foregoing obligation is such that if the said Principal shall well and truly indemnify and save harmless the said Obligee from any pecuniary loss resulting from the breach of any of the terms, covenants, and conditions of the said contract on the part of the said Principal to be performed, then this obligation shall be void; otherwise to remain in full force and effect in law: PROVIDED, however, that this bond is issued subject to the following conditions and provisions:

**First.**—That no liability shall attach to the Surety hereunder unless, in the event of any default on the part of the Principal in the performance of any of the terms, covenants, or conditions of the said contract, the Obligee shall promptly and immediately upon knowledge thereof, and in any event not later than thirty days after the occurrence of such default, deliver to the Surety at its office in the City of Boston, Penna., written notice thereof with a statement of the principal facts showing such default and the date thereof; nor unless the said Obligee shall deliver written notice to the Surety at its office aforesaid before making to the Principal the final payment provided for under the contract herein referred to.

**Second.**—That in case of such default on the part of the Principal, the Surety shall have the right, if it so desire, to assume and complete or procure the completion of said contract; and in case of such default, the Surety shall be subrogated and entitled to all the rights and properties of the Principal arising out of the said contract and otherwise, including all securities and indemnities theretofore received by the Obligee and all deferred payments, retained percentages and credits, due to the Principal at the time of such default, or to become due thereafter by the terms and dates of the contract

**Third.**—That in no event shall the Surety be liable for a greater sum than the penalty of this bond, or subject to any suit, action, or other proceeding thereon that is instituted later than the 31st day of December A. D. 1906.

**Fourth.**—That in no event shall the Surety be liable for any damage resulting from, or for the construction or repair of any work damaged or destroyed by an act of God, or the public enemies, or mobs, or riots, or civil commotion, or by employes leaving the work being done under the said contract on account of so-called "strikes" or labor difficulties.

FORM 9

**In Testimony Whereof,** the said Principal has caused these presents to be sealed with its corporate seal, attested by the signature of its duly authorized officers, and the said Surety has caused these presents to be sealed with its corporate seal, attested by the signatures of its_____ President and its_____ Secretary the day and year first above written.

Signed, sealed and delivered
in the presence of

John Smith

Albert Jones

John A. Walker
President

Attest: Edward Ames
Secretary

**The Colonial Title Guaranty Company of Boston, Penna.**

William A. Blank
President

Attest: E. G. Baker
Secretary

FORM 10

No.

**The Colonial Title Guaranty Company**

**OF BOSTON, PENNA.**

## CONTRACT BOND

$ 14,000

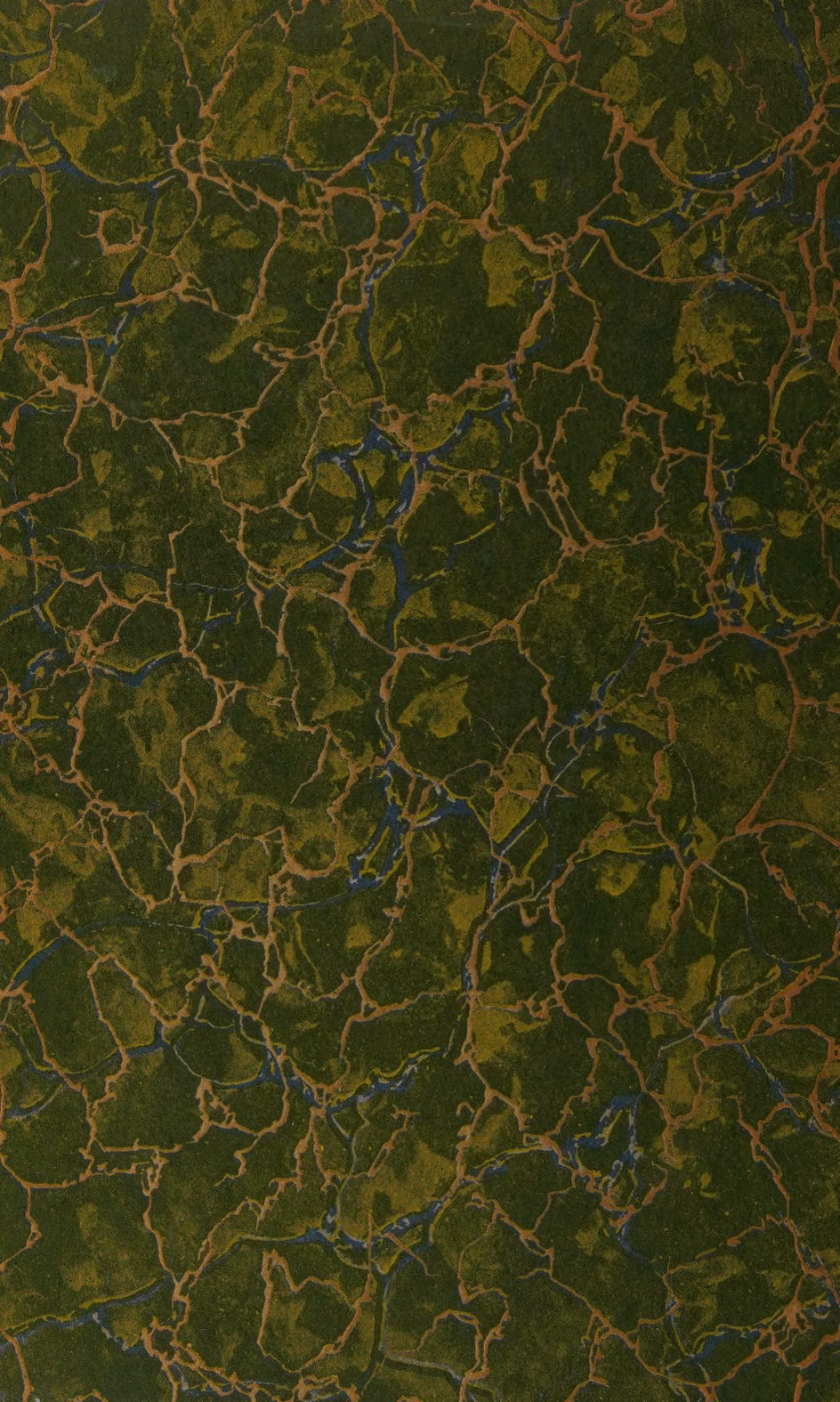
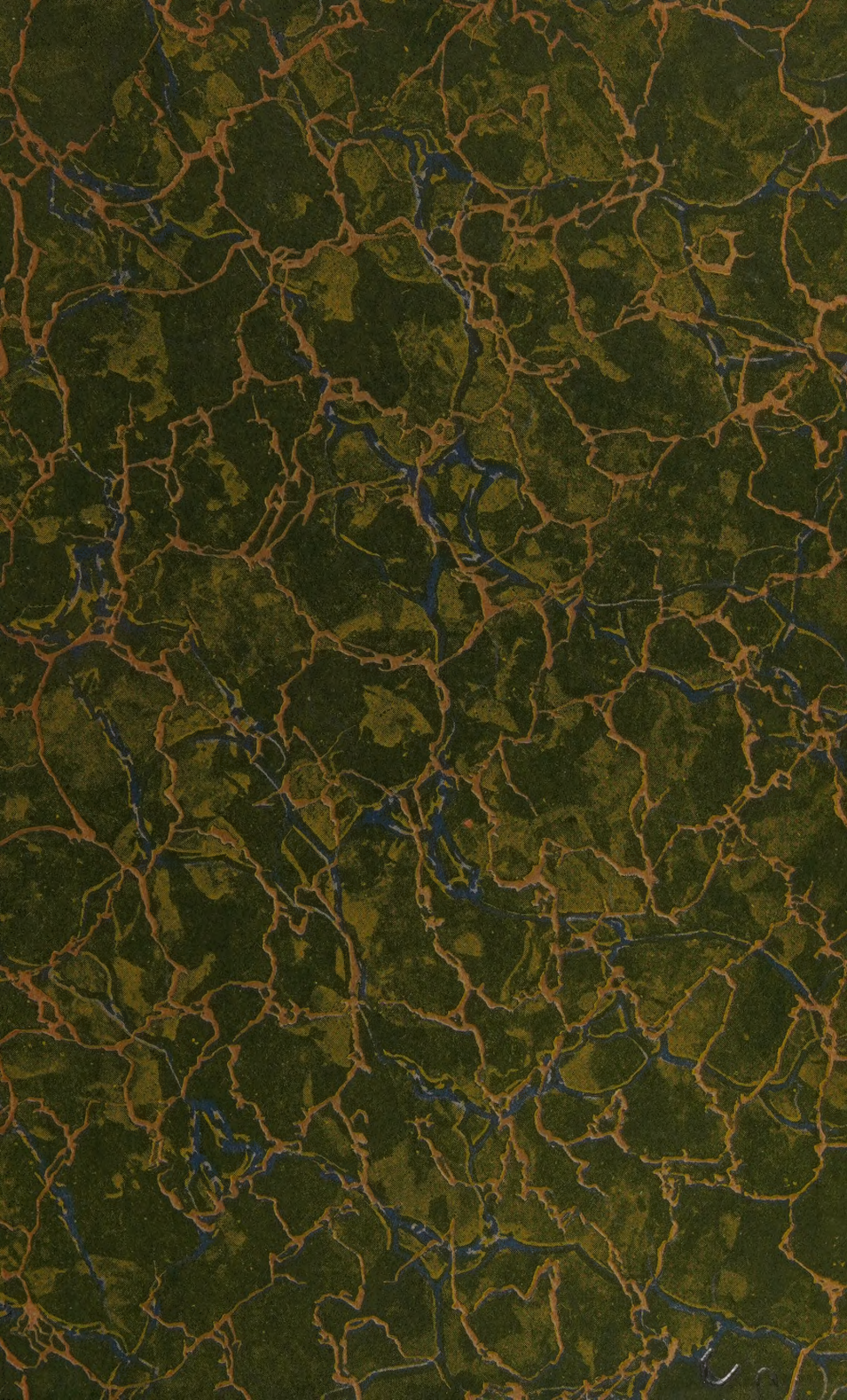
ON BEHALF OF

The Scranton Construction Co.

TO

John Jones

Date Jan. 18 1906

Expires July 18 1906

FORM 11